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GALLATIN CANYON

FINAL REPORT

THE MURRAY-McCORMICK ENVIRONMENTAL GROUP

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THE GALLATIN CANYON PLANNING STUDY

FINAL REPORT

The Murray-McCormick Environmental Group
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Submitted to:

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Economic Development
State of Montana
Helena, Montana

July 14, 1972

This report EP&D, #0770-0010 is approved in form and content for submittal by The Murray-McCormick Environmental Group

Ernest L. Seeman
Director of
Applied Science

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We wish to express appreciation to the many State and Federal agencies in Montana who provided data related to Gallatin Canyon and its environs. Special thanks are extended to the U.S. Forest Service, Gallatin Ranger District, for their helpful cooperation and interest. Appreciation is also extended to the Montana State University Study Team and particularly to Dr. Gerald Nielsen and Mr. Bruce Leeson for their extensive help in soils mapping and analysis. Most particularly we would like to thank the Gallatin Canyon Planning Study Committee and all the interested private citizens for contributing to the many long discussions concerning planning for their Canyon.

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FOREWORD

This report is part of a series of elements that, together, constitute the Comprehensive Plan for the Gallatin Canyon Planning Area. The various elements forming the Comprehensive Plan are as follows:

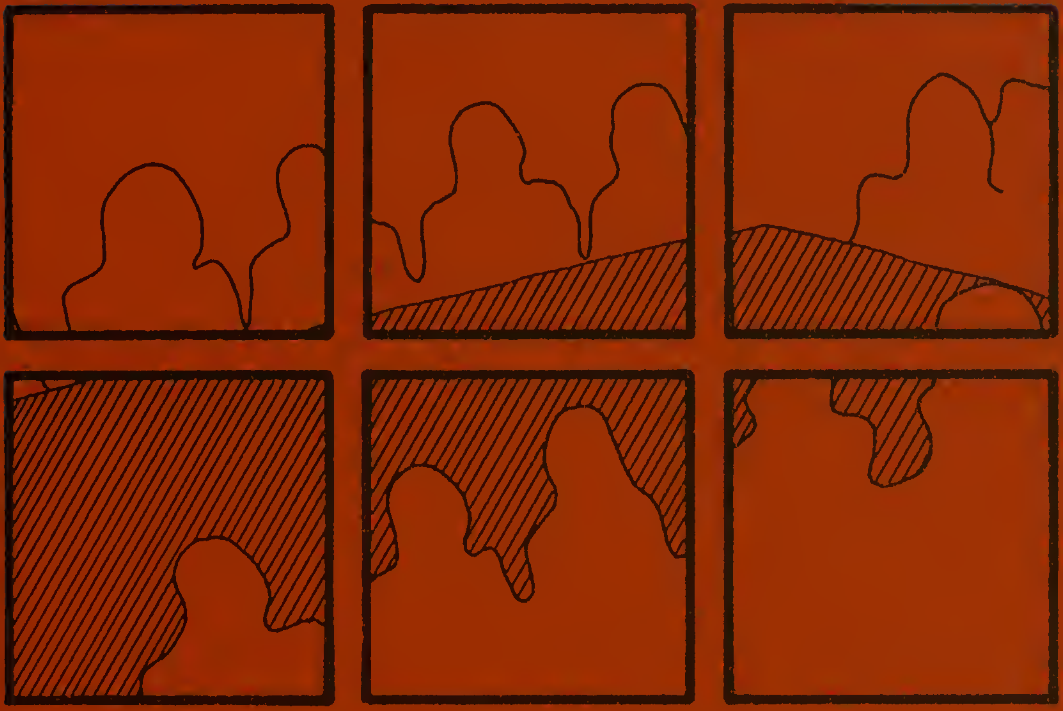
I. Environmental Resource Survey and Implications Analysis--Inventory of natural and cultural features and explanation of their implications toward development.

II. Environmental Impacts Summary--Analysis of impacts of planned projects on the environment.

III. Land Use and Circulation Alternatives--Presenting possible alternate directions for future growth and development.

IV. Implementation Guidelines--Discussion of guidelines, and management and monitoring programs, necessary to develop recommended land use directions.

PROJECT ORGANIZATION



CITIZEN PARTICIPATION

INTRODUCTION

This final report presents the full technical detail of the Gallatin Canyon Planning Study, conducted for the State of Montana, Department of Planning and Economic Development. Condensed information is available in the accompanying Summary Report.

This Comprehensive Plan for Gallatin Canyon is directed to guiding overall development activities in the Canyon, particularly as those activities relate to the scenic natural environment. Continuing development within the Canyon has been an issue of wide interest for many years, most recently focusing on the Big Sky of Montana, Inc. recreation development. Of great concern has been the possible impacts such continuing development might have on the natural environment.

There have been several attempts to initiate some form of planning program for Gallatin Canyon. Before and after Big Sky's announcement of locating a recreational development in Gallatin Canyon, there were efforts made to begin some form of planning and zoning, but all failed. A series of informal meetings were held, eventually establishing a landowners association entitled The Gallatin Canyon Property Owners Association.

From this group a petition was passed in the Canyon requesting the State Planning Department to help start a planning program. Eventually a study was started with appropriate funding and with a citizens group, the Gallatin Canyon Planning Study Committee, appointed by Governor Forest Anderson.

The involvement of citizens as well as groups and agencies was an important step in the planning process. The Comprehensive Plan submitted as a part of this study has been developed with the extensive help of the Gallatin Canyon Planning Study Committee.

Comments regarding the future of Gallatin Canyon heard from residents participating on the Planning Study Committee and in public meetings are summarized in the following findings.

> Citizens are concerned about the issues of current construction development and its immediate impact on the environment as well as long range planning to maintain environmental quality.
>
> The impact of citizen interest has been strongly felt by their insistence upon starting a planning program for Gallatin Canyon.
>
> Strong interest has been generated around the impact of the construction of the large year-round recreational development, Big Sky, on the relatively "unspoiled" Gallatin environment.
>
> The majority of citizens who participated in this study expressed views in opposition to the widening of Highway 191.
>
> Citizens who participated in this study generally favored the maintenance of high environmental quality standards, particularly those related to water and air.
>
> Those participating in this study generally advocated future development adhere to a general plan.

Citizen involvement in the continuing planning of Gallatin Canyon is essential. Because Gallatin Canyon has so much to gain from preservation of its scenic environment and natural resources, the citizens of the Canyon should continue to do everything possible to assist in the development of this planning process. Planning program administrators should involve identified citizen groups prior to making decisions on specific public improvements. A balance must be struck between the potentially adverse effects of increasing development on adjacent land uses and on the quality of the environment.

COMMUNITY VALUES

Development of Citizen Goals and Objectives

Gallatin Canyon is a principle watershed, natural resource, and recreation area. These particular characteristics offer the basic parameters in determining the goals and objectives to set the stage for planning future development. The comprehensive land use plan and guidelines must relate to the enhancement, conservation and wise use of the natural environmental features of the Canyon.

As previously mentioned, a number of citizen's groups and committees have been formed throughout the study area in the attempt to formulate a planning program designed to cope with development pressures. The Gallatin Canyon Planning Study Committee is the result of this interest to accommodate further development and at the same time protect and enhance identified ecological values.

In the course of the planning program the Study Committee was asked to document community attitudes and values, resulting in a list of recommended goals and objectives. These were necessary in the program to describe the kind of Canyon the people wanted, and the kind it should be in the future. The general long range goals and objectives of the Canyon are to conserve and develop its great natural resources and promote the public health, safety, peace, comfort, convenience, and general welfare for the present and future citizens and visitors to the Canyon.

Following is a list of general goals developed to establish the intent and direction of planning activities within Gallatin Canyon. In planning these goals and objectives, Gallatin Canyon was considered as:

> A unique area possessing great water and timber resources, providing the state and nation opportunities for resource and recreation development;
>
> A great outdoor recreation and open space area with unexcelled scenic beauty, abundant fish and game, and excellent climate, providing diversified opportunities for not only local residents, but for the state and nation as well; and
>
> A desirable place to live and work in and to visit, with a healthful, smog-free atmosphere, without the problems of overcrowding, and with excellent opportunities for constructive use of leisure time.

General Goals

Prepare suitable land use alternatives for the environmental enhancement of the entire region to be strengthened by recommended guidelines that provide control of the physical environment.

Develop and maintain cooperation and coordination of government agencies--local, state, and federal--responsible for the creation and presevation of the present quality of life in the Gallatin Canyon area.

Coordinate planning efforts including goals, plans, and programs of local, state, and federal agencies relating to open space, recreation facilities, and scenic preservation for residents and tourists that visit the Canyon area annually.

Enhance the social, cultural, and recreational activities in the Canyon while preserving the ecological and environmental values of the region.

Protect and preserve the existing ecosystem from unnecessary alteration and disturbance.

Environmental Goals

Encourage preservation of the natural environment and scenic values of the Canyon.

Encourage coordination of both public and private forest management practices and recommend logging guidelines designed to protect and enhance the existing environmental quality of the Canyon.

Preserve stream and river channels and riparian vegetation from unnecessary alteration and disturbance.

Establish water quality standards for major streams and maintain them through constant monitoring.

Establish air pollution control measures and monitor air pollution henceforth.

Develop and apply adequate erosion control guidelines to all new construction.

Preserve and enhance the fish and wildlife habitat.

Study and develop a program for solid waste and garbage collection and disposal for business, residential, and recreational uses.

Provide for sewage disposal and treatment standards designed to protect the water quality of streams and rivers in the Canyon.

Encourage development of fire protection services for the entire Canyon area and investigate the formation of a Gallatin Canyon Fire Protection Agency. Coordinate volunteer fire fighting units where structure concentrations warrant.

Community Design

Keep all future development in character with the special natural environment of Gallatin Canyon.

Encourage site planning and building and landscape design to result in an attractive appearance from the highway, and a harmonious relationship among the various elements of the development and with the landscape.

Establish development guidelines and visual standards for new construction, including guides for signing, highway and development treatments, exterior motifs, utility distribution lines, and screening vegetation.

Take care not to obstruct important vistas and views within the Canyon. A variety of standards should be developed in order to achieve this purpose under different conditions.

Develop land use alternatives designed to enhance the compatibility of existing and new land uses in the Canyon.

Develop standards on signing and display advertising to establish certain size, color, and design limitations to blend with the natural environment.

Provide adequate facilities for community services to residents and visitors in the Canyon.

Visually screen mobile homes and recreational vehicles from major circulation routes.

Land Use Activities

Provide for additional residential and tourist/recreation developments in the Canyon and develop guidelines to enhance the relationships between such development and the natural environment.

Limit further commercial development to concentrated facilities necessary to the support of recreation oriented activities and to selected sites where such development would be compatible with other land uses.

Insure commercial areas are easily accessible from primary circulation routes and prohibit noxious business and industrial uses from the Canyon.

Control the development of recreational land uses in the Canyon and limit them to activities that depend upon, and are compatible with, retention of the area's natural character.

Encourage no further industrial activities to locate within the Canyon.

Circulation

Develop the Gallatin Highway 191 as a scenic highway, with recommended guidelines for development activities along the highway and adjacent off-highway use.

Develop an adequate transportation and circulation system that has a minimal impact on the present environment.

Adopt and put into practice design standards, speed controls, sound controls, and enforcement intended to improve the safety, usability, and visual enjoyment of Highway 191.

Encourage the elimination of nonessential trucking activities from Highway 191.

Direct highway access to abutting properties should be limited in number.

Restrict construction work on Highway 191 to normal maintenance and minor improvements including scenic turn outs, safety islands, protected turning movements, pedestrian crossings, signed animal crossings, and traffic control signing, where needed.

These basic goals and objectives are of foremost importance and formed the basis for determining the direction of this study. They were adopted by the Gallatin Canyon Planning Study Committee on August 12, 1971, to guide the planning program.

Conflicting Community Values

One of the major handicaps in the planning program is the apparent inconsistency or conflict represented by the desired degree of growth and development. Citizens attending public meetings seem to be in general agreement that the Canyon can not support continued, uncontrolled growth. However, no agreement has been reached as to how growth should be controlled. A strong desire has been expressed against traditional land use zoning control.

Among the examples of apparent inconsistencies or conflicts in community values is the treatment of Highway 191. Canyon residents have indicated a general agreement that the road not be widened to accommodate additional traffic. At the same time, they have indicated a planning goal of providing for additional residential and tourist/recreation developments. While it is apparent the road will handle more traffic than it presently does, keeping it to a two lane facility will definitely limit future development within the Canyon.

These apparent inconsistencies or conflicts between goals and objectives and planned development have been met by giving overriding attention to the basic idea preparing a land use plan providing for the enhancement and control of the total physical environment.

ENVIRONMENTAL RESOURCE SURVEY

INTRODUCTION

Many of the abuses to the natural environment derive from man's ignorance in the operation of the physical and biological processes, and the extension of this ignorance and related disregard to the planning process. Prudent, sensitive use of the environment dictates an appreciation of nature as process, responding to natural laws and resulting in reasonable, predictable patterns. This understanding of nature should be developed as the foundation for land use planning and for analysis of the impact of those plans on the environment in which they will be effectuated.

Objectives of Study

The Gallatin Canyon is a resource worthy of protection for all the citizens of Montana and visitors to the State. The objective of the Environmental Resource Study is to present the basic facts about the total environment of the Gallatin Canyon study area (Figure I-1). These facts, taken together, constitute the conditions at the site at the time of the initiation of the study* and as such are the "baseline" on which the proposed land use activities and related plans can be developed and evaluated. This report will include a delineation of the natural and cultural resources, and a determination of the natural constraints to development in the area.

Scope and Limitations

The natural and cultural environmental processes must be examined over *time* as well as *place* to approach a complete comprehensive analysis. Because of the duration of the study (180 days) and its budget limitations, it has been necessary to restrict the background environmental research to compiling and analyzing existing data. Additional background studies are being developed by the Center for Environmental Studies at Montana State University.

---

*February, 1971

The Montana State University study, while not a planning study, has been organized to determine the social, economic, and ecological changes resulting from the entry of a large recreation development into a relatively primitive and unspoiled area. This study centers around the Big Sky of Montana recreational complex, currently under Phase I construction in the West Fork Area of the Canyon. This complex provides a useful opportunity to measure the potential impact of such developments on the physical and social environments. It is the objective of the MSU Study to measure such an impact through a multi-disciplinary team approach, initiated in the summer of 1970 with supporting funds from the National Science Foundation.

It has been necessary in this report, because of time and budget limitations, to rely on previously published materials and on brief site reconnaissance specifically directed either to provide an overview of the study area or to determine specific facts. Every effort has been made to utilize available data from the MSU Study and other sources in order to eliminate duplicative efforts. The environmental resource survey is a compilation of the best available data and its analysis and summation by a team, well trained in the disciplines of the environmental sciences.

PROJECT LOCATION

The project area is situated in southwestern Montana between the Gallatin and Madison Mountain Ranges. The Gallatin River Valley has a dual nature. "It forms a canyon from its origin along the western border of Yellowstone Park for some sixty miles; then it leaves the mountains to flow through a broad fertile agricultural valley. The canyon is heavily timbered throughout, and its rocky cliffs suggest rich mineral wealth."*

Each element of the natural environment (landforms and geology, climatology, hydrology, vegetation, soils and wildlife) shows characteristics typical of the Rocky Mountain Range, and each element of the cultural environment (existing land uses, circulation, demographic features, land ownership, utilities and related services, economic character, and governmental aspects) reflects rural, highland human activities. This study does not address itself to any proposed development but instead is to develop land use recommendations for the future development of the Canyon.

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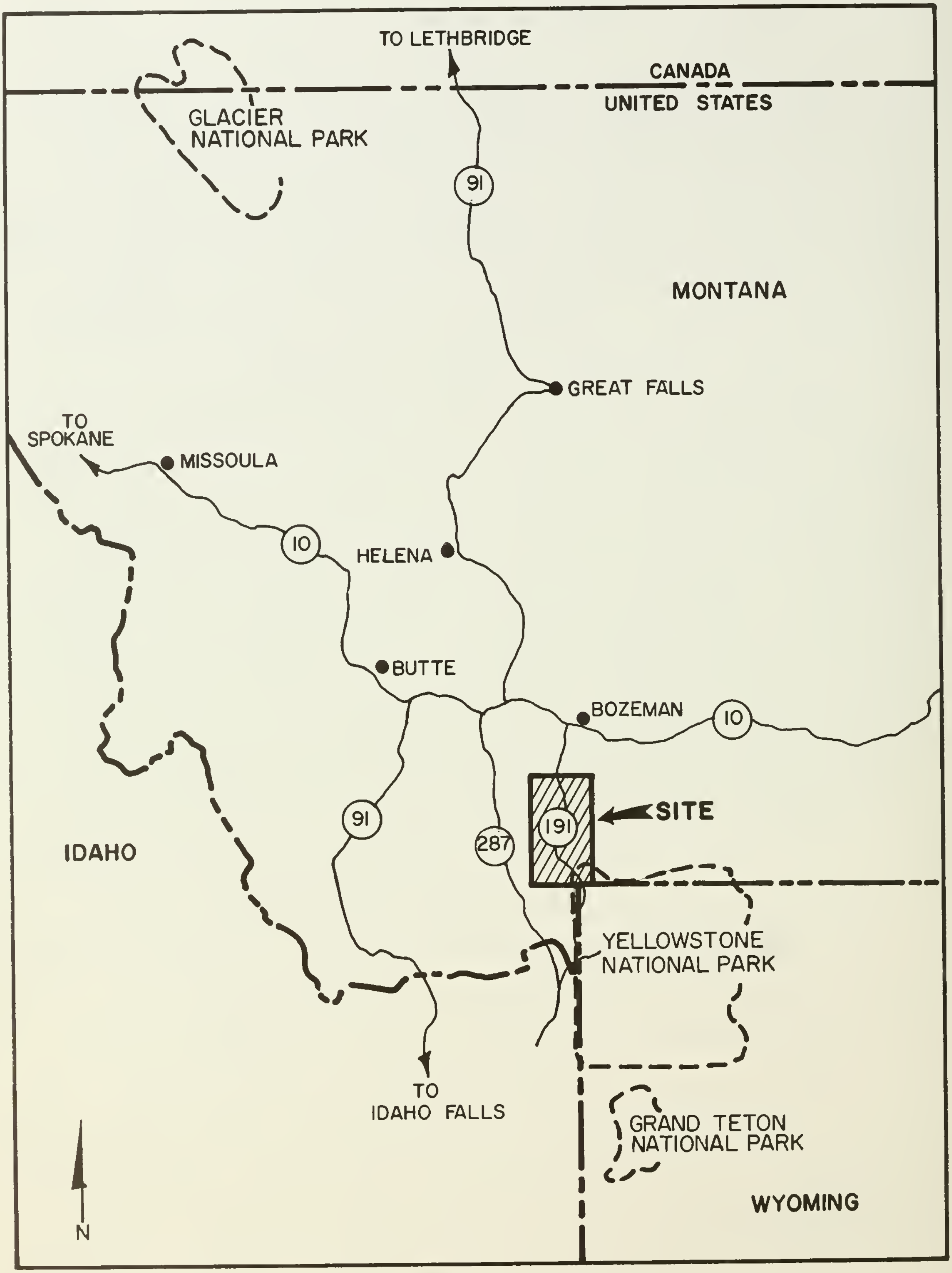
*Burlingame (1970)


TO LETHBRIDGE
CANADA
UNITED STATES
GLACIER NATIONAL PARK
91
MONTANA
GREAT FALLS
TO SPOKANE
MISSOULA
10
HELENA
BUTTE
BOZEMAN
10
SITE
191
91
287
IDAHO
YELLOWSTONE NATIONAL PARK
TO IDAHO FALLS
GRAND TETON NATIONAL PARK
WYOMING
N

REGIONAL SETTING

Of initial importance to the Environmental Resource Study is the general, regional setting of the study area.

Natural Setting

The Gallatin Canyon is in many respects a unique place, with a tremendous variety of natural environments inhabited by a wide range of plants and animals. It lies in some of the most rugged and most beautiful terrain in the United States. The Canyon, an area of approximately 950 square miles, extends north and south thirty-five miles between the Gallatin and Madison Mountain Ranges. The Madison and Gallatin Ranges are outstanding examples of uplifted anticlinal folds common to the Rocky Mountain region. The ranges have been formed primarily through extensive compression and related crustal activity, and the subsequent erosive action of water and ice. Running along the Canyon floor is the famous Gallatin River, beginning in nearby Yellowstone National Park. Highway 191 follows the river along the Canyon floor and provides limited access to the entire study area. The Canyon exhibits all the general aesthetic characteristics of the environment of Yellowstone National Park.

The climate of the region is controlled primarily by its proximite location to the Continental Divide. Distinct seasonal variations are the rule. The seasonal fluctuations involve occasionally severe winter storms, heavy spring precipitation, and warm summer days. The nickname, "Big Sky Country," is appropriate for the strong cloud patterns that frequently break the clear blue sky.

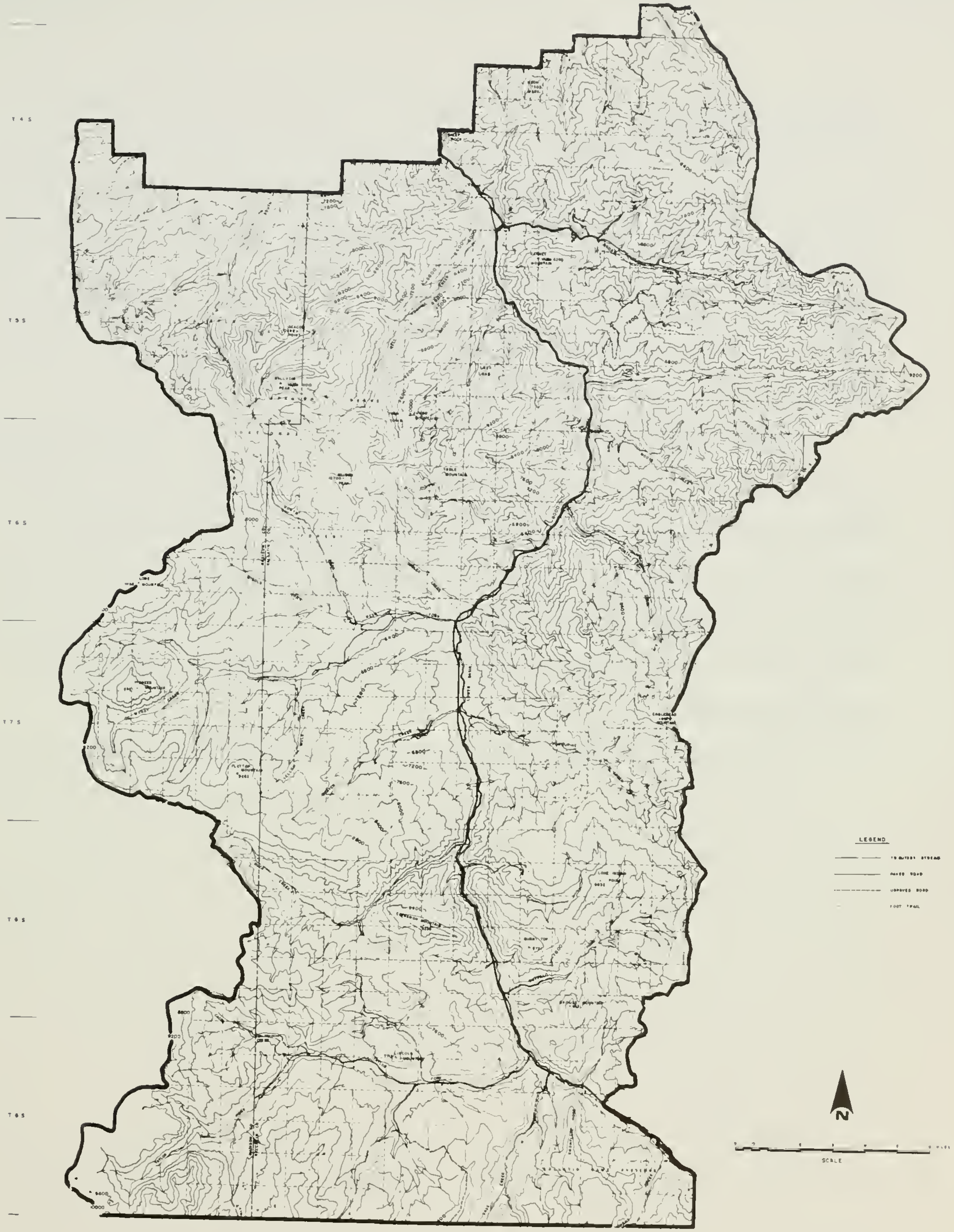
The landscape management zones, defined by the U. S. Forest Service for the Gallatin Ranger District, form a good indicator of ecological systems in the region. These zone associations are the direct result of the geomorphology, geology, exposure, climate, hydrology, and soils of the area.

The general profile of these zones are described in the Multiple Land Use Management Guide for the Gallatin Ranger District as follows:

> General Forest Zone: "This zone comprises the broad, mid-elevation areas above which is located the High Area Zone. This zone is generally characterized by a timber cover of lodgepole pine, Douglas fir, spruce, and alpine fir with intermediate high open ridges and intermingling parks of open grassland and sagebrush. Lodgepole pine is the predominant coniferous species type, comprising about 75% of the timber cover. The elevation varies from 5,200 to 8,500 feet. There are three basin-like areas in the southern half of the district. These basins are characterized by open grassland or sagebrush with a scattering of coniferous timber, usually occurring on north slopes or along water courses."*
>
> Crest Zone: This zone extends upward from the General Forest Zone and lies along both the Gallatin-Yellowstone and Gallatin-Madison Divides. A good portion of this zone is characterized by high rugged peaks, mainly in the headwaters of Squaw Creek, Sage Creek, Taylor Fork, and Spanish Creek. The balance is high, open ridges with a scattering of alpine and sub-alpine vegetation types and thinly-timbered basins at the heads of streams. This zone is an important producer of water and a regulator of stream flow. In the open basins at the heads of streams, many large snowbanks form in depressions, water courses, on north sides of steep banks and escarpments, and on the lee side of windbreaks. This zone is very scenic, offering exceptionally beautiful panoramic views from the high, open ridges.*
>
> Water Influence Zone: This zone is best described as generally following the Gallatin River and its principal tributaries, and as such it transects other zones. The zone is usually irregular in depth, depending on the water environment and the character of the terrain and vegetation. The growing season, climatic conditions, soil characteristics, and topography are generally the same as the zone or zones through which it passes. The differences which may exist are usually caused by the proximity to water and the moisture available to shoreline vegetation.*

---

*Multiple Use Management Guide (1967)



GALLATIN CANYON PLANNING STUDY

GALLATIN CANYON PLANNING STUDY

Figure I-1

Cultural Setting

Just as the project area is situated in an area of transition in the physical environment, so it is in an area of transition in the cultural setting. The Big Sky recreational development typifies the kind of expanding activity coming to the area. The Canyon's enhancing environmental features will continue to exert an increasing influence on corresponding recreational development.

Urban Concentrations. The existing regional urban development pattern is centered around the nearby city of Bozeman. While the majority of growth continues around Bozeman, the unincorporated areas of Bozeman, Hot Springs, and Gallatin Gateway are also experiencing continuous subdivision growth. Gallatin Canyon lies between the path of this growth and the major recreational activities in Yellowstone National Park.

Dominant growth in the Canyon is concentrated around the Big Sky development in the West Fork area (west fork of the Gallatin River). Gallatin Canyon, formerly occupied by small dude and livestock ranches, has in recent years been invaded by summer homes and cabins. There are also an increasing number of permanent homes in the area occupied primarily by retired persons. Resident population (including summer and part-time residents) of the Canyon is about 300 families.*

Montana State Highway 191 provides the only linking transportion route in the Canyon. It connects to Interstate 90 to the north and Yellowstone Park and the Tetons to the south. Settlement in the Canyon has located around Highway 191.

---

*The Impact of a Large Recreational Development Upon a Semi-Primitive Environment: A Case Study (1970)

The natural resources attributed to the Gallatin Canyon area include mountainous terrain, blue-ribbon streams and rivers, mature forests, and a refreshing climate. These resources have attracted tourists and created unique recreation opportunities. People from nearby urban centers and distant cities come to Gallatin Canyon to share in the region's natural environment.

The future character, economy, and general attraction to the visiting tourist depends upon the Canyon's ability to preserve its unique qualities not available elsewhere.

Transportation. Highway 191 presently offers the only paved all-weather route through the Canyon. It serves as a major transportation route connecting Bozeman and western Montana with cities to the south. A problem of concern on this highway has been the increasingly heavy truck traffic. Little of this truck traffic serves the Canyon directly, and in fact its very presence through the Canyon raises considerable concern.

The Gallatin Canyon Planning Study Committee defines as a future goal the development of Gallatin Highway 191 as a scenic highway. It is recognized that future improvements to the highway should be made only as they relate to recreational use activities.

Study indicates the demands will continue on Highway 191 to serve as a major recreation access corridor in the area. The treatment of land use activities contiguous to this corridor will greatly affect the environmental quality of the Canyon as it continues to develop.

Other transportation modes, bus, rail, and airport facilities are located in or around Bozeman. Amtrak, the new National Rail

Passenger Service, now serves Montana. The nearest airport to the study area is Bozeman, which is used for general aviation and located eight miles northwest of the city. A second airport is located in the city of West Yellowstone and is open only during the summer tourist season. Both are jet airports served by major scheduled U. S. airlines. A general increase in transit passengers is expected to continue.

Population Trends. While no specific population projections are available for Gallatin Canyon, a general forecast has been completed for Region IV (Southwestern Montana), an area including Gallatin County, by the University of Montana, Bureau of Business and Economic Research.* This report, while very general, indicates a modest increase in Region IV's population through 1980. It does indicate tourism will continue to be an important factor in increased activity, particularly due to the close proximity to Yellowstone Park as well as excellent hunting and fishing in the area. Yellowstone National Park received over 2.1 million visitors in 1968, and this figure has been increasing since. Increasing leisure time is certain to bring more people to the mountain areas part of the year. Furthermore, the construction of year round recreational facilities at Big Sky will promote new interest and visitation to the area.

Overall Development and Growth Patterns. Gallatin Canyon is on the threshold of change from an isolated ranching and wilderness country, to an active recreational development serving the entire western United States. Land is being sold and subdivided at an increasing rate in the Gallatin area with some major building beginning. The expected development can either alter the landscape, well known and valued, or it can utilize the advantages of the natural environment and resourcefulness of the residents and landowners.

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*Montana Economic Study (1970)

At present the land is devoted primarily to forest and ranching activities. It must be assumed that ranching is in a marginal and transitional phase, and is not likely to be able to compete with residential and recreational-related development. Recent and pending land exchanges between the U. S. Government and private landowners significantly alter the development potential.

New activities and public interest have centered around the Big Sky recreation project. Big Sky is being promoted as on its way to becoming "one of the most beautiful and complete recreation and leisure areas in America."* It will offer year round recreation facilities centering around skiing activities on nearby Lone Mountain (elevation 11,165'). When Big Sky of Montana is completed it will consist of two separate "villages" at the base of Lone Mountain, and be accessible from Highway 191 through a road up the West Fork area. Market studies conducted for Big Sky by Real Estate Research Corporation have shown economic and physical conditions favorable for a development of this nature.*

The present mountainous, rural landscape lends itself to a number of recreational activities, but this potential is threatened by future intensive development. It is the premise of this report that Gallatin Canyon deserves the best of treatment. Its aesthetic values are such that development should be based upon a respect for and understanding of the landscape character.

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*Big Sky Montana General Plan (1970)

NATURAL ENVIRONMENT

The natural elements of the environment of the Gallatin Canyon region consist of: geology and geomorphology; climatology; hydrology; vegetation; soils; and fish and wildlife. These elements are presented in this section.

GEOMORPHOLOGY AND GEOLOGY

Due to the nature and scope of this study only the salient aspects of the geomorphology and geology of the study area, and their implied limitations to development, are summarized in this report. Detailed accounts of the geologic history, structure and mineral deposits may be reviewed in the reference volumes listed in the bibliography.

The Madison and Gallatin Ranges occupy the southeastern end of the northern Rocky Mountain Physiographic Province. Structurally they could be grouped with the ranges of the central Rocky Mountain Tectonic Province. In general, these ranges are broadly uplifted assymmetric anticlinal folds, bounded on their margins by prominent faults. The thin mantles of shallow Paleozoic and Mesozoic marine sediment have for the most part been eroded away exposing precambrian crystalline basement rocks. The Madison-Gallatin area has a not unsimilar structure.

Physiographic Features

The Madison and Gallatin Ranges are a single structural entity. Physiographically this uplifted block is primarily a product of the erosive action of running water and ice. The study area has been dissected by the Gallatin River and its tributaries and currently exists in a stage of early maturity. Tributary streams to the Gallatin River are youthful. Rapids are common along the stream courses, with incipient meanders in limited stretches of alluvial flats. The valleys are predominantly

V-shaped, and lacking in broad upland divide surface.

General Geomorphology

Generally the Madison-Gallatin block is a broad area of sedimentary rocks compressed between Precambrian crystalline buttresses at the northeast and southwest. Within the study area, faults and folds, as well as their physiographic expressions, are results of this compression. Spanish Peaks fault is the most prominent structural element in the area. Trenching northwest-southeast, it traverses the entire study area. This high angle reverse fault is post-late Cretaceous in age and has helped create several miles of impressive "hogbacks" or "flatirons" on either side of the Gallatin River.

For further detail regarding the structural complexity of the study area the reader is referred to Hall, 1960, which contains an excellent description of the complex structure of the study area.

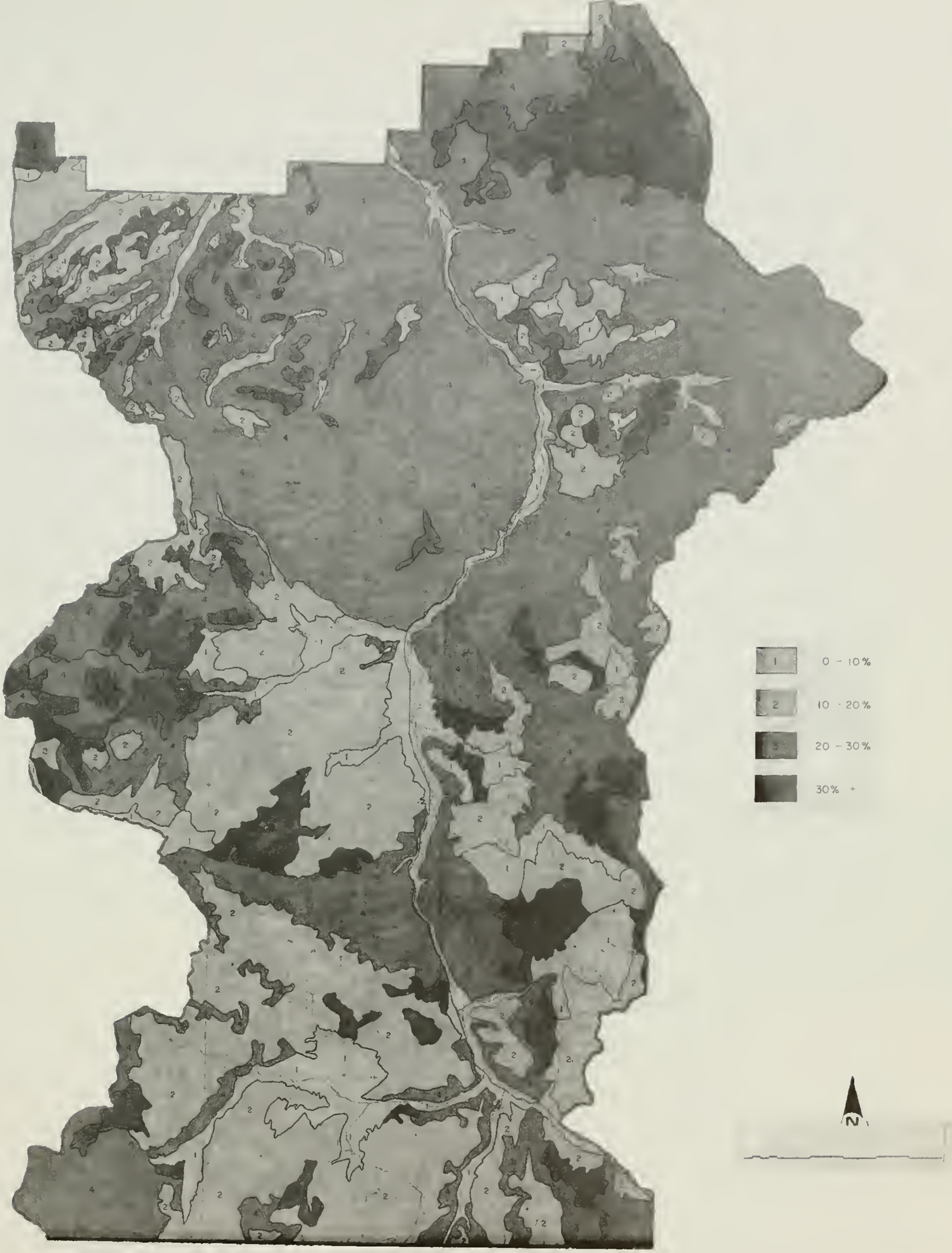
Glaciation. During the Pleistocene the upper reaches of this area were subject to at least four stages of glaciation: 1) Pocket-glacier stage; 2) Sawmill stage; 3) Intermediate stage and; 4) Marble Point stage. As a result, morainal and other glacial deposits are common throughout much of the upper elevations in the study area. For specific accounts of these glacial episodes the reader is referred to Hall, 1960.

Mass Gravity Movements. In reviewing the history of geologic formation in the Gallatin Canyon it became apparent that a major factor in the evolution of landforms in this area was mass gravity movements. It is estimated that 20 to 25% of the surface area have landforms determined by mass wasteage. This includes features such as talus slopes, slumps, soil creep, landslides, mudflows, etc. This becomes significant in terms of development planning. Without going into detailed descriptions and characteristics of each type of movement, the following comments should be made:

1) Most often they have occured in areas of rather steep slope.
2) Cretaceous shales, clays and mudstones and bentonites such as the thermopolis and albino formations appear very susceptible to movement.
3) Glacial till also appears to be a source of potential movement.
4) Although many movements occurred in the past under different climatic conditions, it is not unlikely that these types of movements will continue - especially since this is an active area seismically.

An excellent example of a mass gravity movement is the Taylor Fork rockslide (sections 10 and 11, T9S, R4E). Although this slide is believed to be several hundred years old, the potential hazards of this type of mass movement are clearly evident.

Slope Conditions. The relief within the study area is in excess of 5,000 feet. As a result, much of the area is in slope of 35 percent or more. There are relatively few areas of flat (less than 10%) land. These are located along the narrow Gallatin River valley, West Fork valley, and Taylor Creek valley. Difficulties of access and construction on the steep hillsides will effect development in those areas.



SLOPE ANALYSIS

GALLATIN CANYON PLANNING STUDY

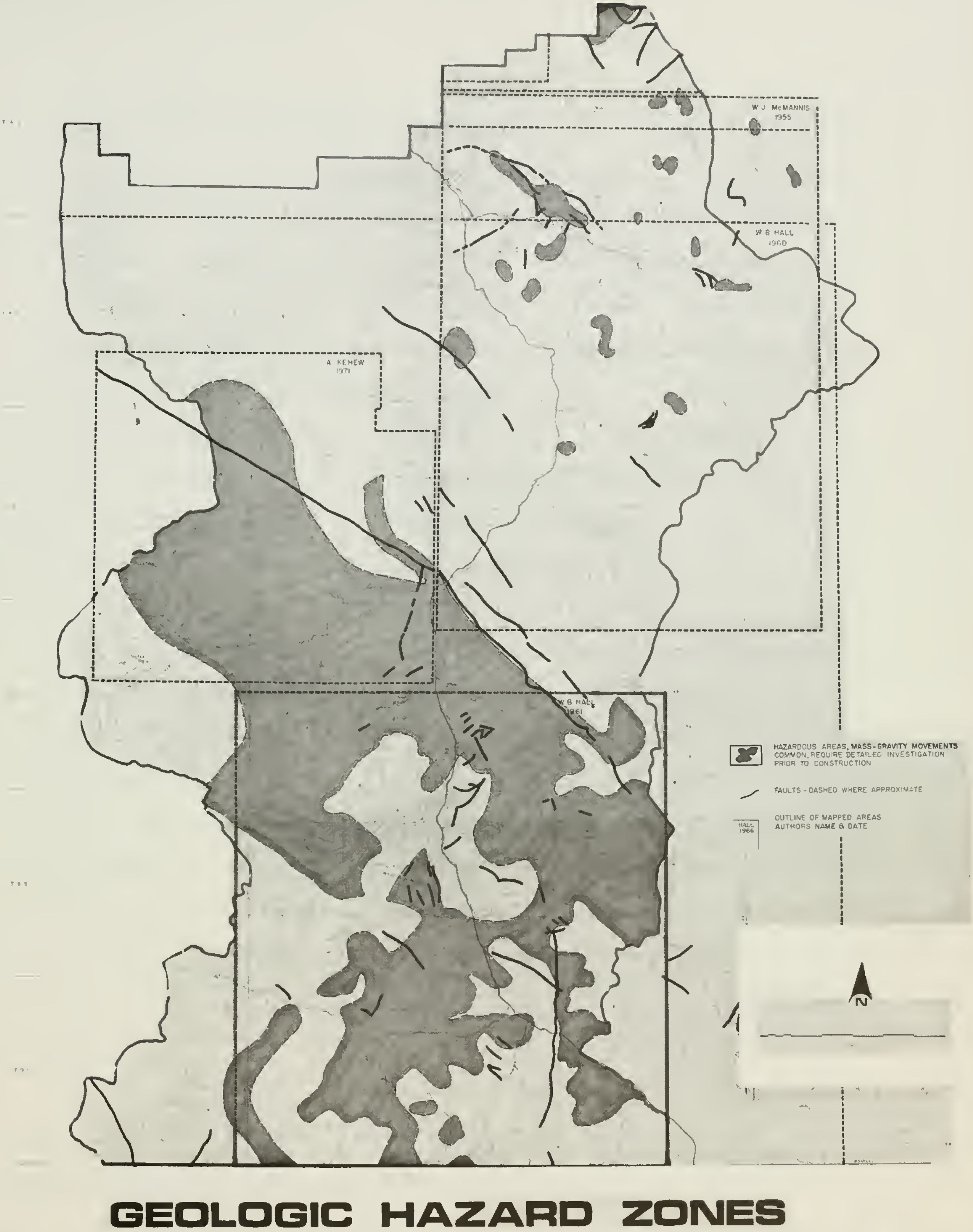
Figure I-2

Drainage. The Gallatin River traverses the study area with an average gradient (upstream from Gallatin Gateway) of 40 feet per mile. Generally the Gallatin River valley is narrow, averaging less than one mile in width with rapids along much of its course. The exact hydrologic-geomorphic history of the Gallatin River and its tributaries is not clear. It appears probable the northward course of the Gallatin is due to the superposition of a middle or late Tertiary stream course (also flowing to the north), upon the complex transverse structure of Madison-Gallatin uplift. Regional uplift in late Tertiary time caused renewed vigor in the streams, resulting in the entrenchment of the river course across the structural trend of the basement rocks previously buried.

The majority of the tributary stream courses appear to be structurally controlled. Their alignments follow the major structural trends such as faults and folds. Much of this alignment has a northwest-southeast orientation.

Faulting and Stability

The Uniform Building Code describes the Gallatin area as being located in zone three, indicating high potential for earthquakes causing major damage. This is on a scale of 0 - 3. Although none of the known faults are active, the area has most recently received seismic shocks of modified Mercallin Scale intensity of VI (scale I - XII). The effects of the Hebgen Earthquake of August 17, 1959, in the Hebgen lake area south of the Canyon, can serve to illustrate some of the problems.


W J McMANNIS
1955
W B HALL
1960
A KEHEW
1971
W B HALL
1961
HAZARDOUS AREAS, MASS-GRAVITY MOVEMENTS COMMON, REQUIRE DETAILED INVESTIGATION PRIOR TO CONSTRUCTION
FAULTS - DASHED WHERE APPROXIMATE
HALL
1966
OUTLINE OF MAPPED AREAS AUTHORS NAME & DATE
N

GEOLOGIC HAZARD ZONES

GALLATIN CANYON PLANNING STUDY

Figure I-3

This quake has been recorded as one of the severest earthquakes recorded on the North American continent. It had a magnitude of about seven on the Richter Scale, which made it a fairly destructive quake. The 1906 San Francisco Earthquake measured about eight. It is a geologically recent area where enormous forces thrust up mountains and where volcanic craters exist. The heat of the earth still spouts its fury through geysers in Yellowstone Park's Firehole Basin. The entire Canyon area requires careful planning and consultation, especially in relation to mass-gravity movement. Buildings should be designed to be as earthquake resistant as possible.

Geologic Implications for Development

The following map of geologic hazards delineates zones or areas that, due to either past activity (landslides, etc.) and/or certain local physical characteristics (expansive clays, etc.) pose serious potential hazards to development. It should not be interpreted as excluding development from any of these areas. However, specific and detailed investigations should be conducted to determine the suitability of each area for any proposed development.

Several considerations have been made in an attempt to delineate these potential hazard zones.

> Stratigraphically many of the units in this area are extremely undesireable for construction development. This may be due to: interbedded shale and sandstones that have proven unstable in the past; presence of weak and/or expansive clays; or the potential effects of tectonic movement (earthquakes).

Areas of historic instability: areas of landslides, slumps, and other mass-gravity type movements.

Location of faults and the potential for movement along these zones.

Factors of slope, vegetative cover, and soils.

Geologically, certain rock types must be considered more fragile or potentially hazardous than others. The Cretaceous age black shales (thermopolis formation) are most susceptible to mass-gravity movement. In this formation, particular caution must be taken in construction. Wherever possible, development is not recommeded on the thermopolis formation. Also, outwash gravels and glacial till overlying these shales pose potential development hazards.

The potential for landslides or other mass-gravity movement is present throughout the entire area. Roadways, building foundations, and other construction should be designed to recognize this potential. In areas of old landslides, care should be taken not to introduce water into the slide mass. This could easily set the slide area in motion again.

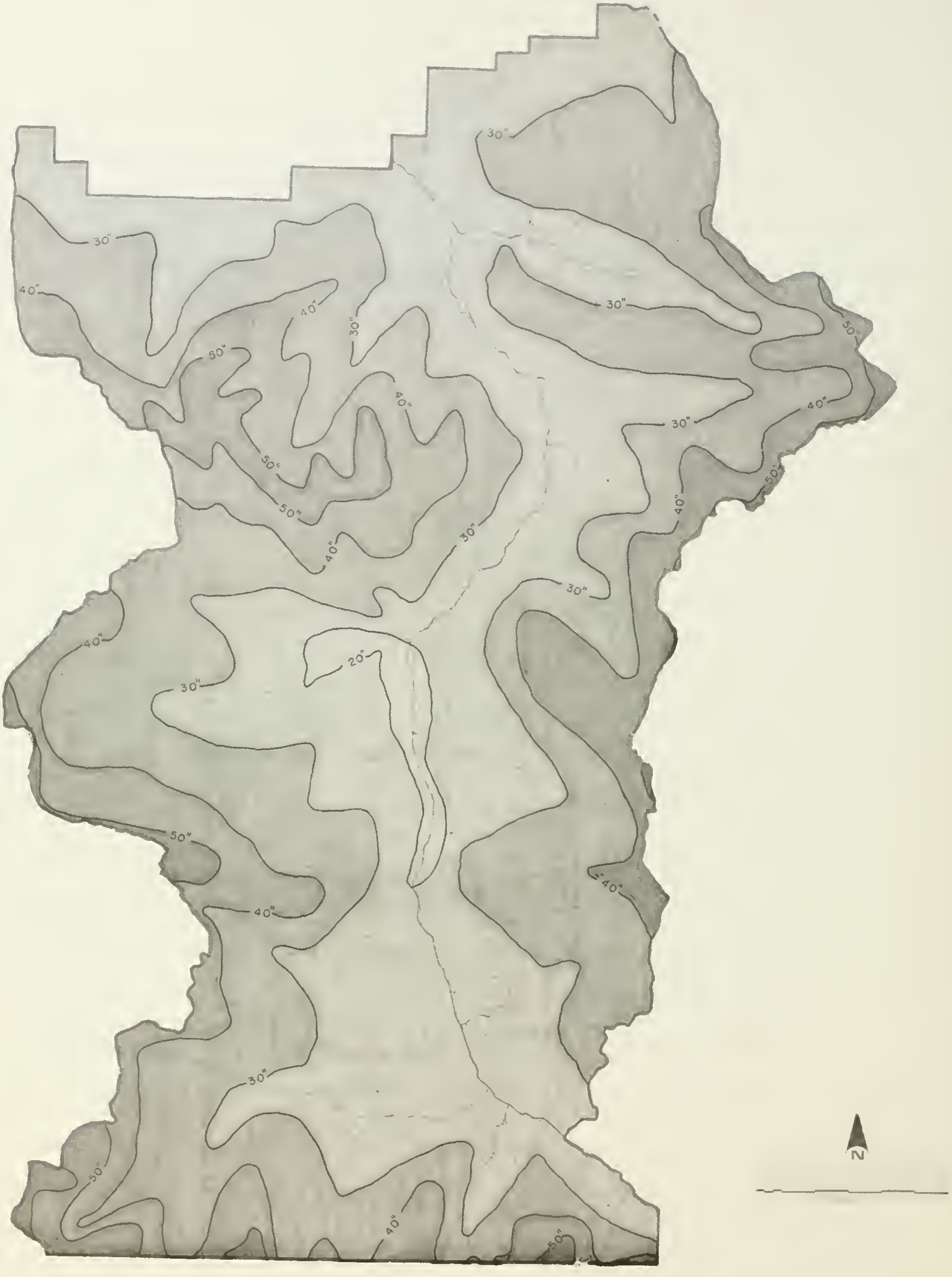
In the alpine and subalpine areas construction on unstable rock glaciers should be prohibited. These are found in the West Fork basin, on the flanks of Lone Mountain and the contiguous drainages.

As the Gallatin Canyon area is active seismically (ref: Hebgen Lake earthquake area), planning and development design should incorporate maximum earthquake safeguards.

CLIMATE

The location of the Continental Divide, topographic features and elevation variations become key elements in defining the climate in the planning area. West of the Continental Divide the climate tends to be controlled by the flow of moist, Pacific marine air. East of the Divide it becomes continental in nature with outbreaks of dry, often cold air from Canada, and southerly, moist air from the Gulf of Mexico. Although the planning area is east of the Divide, the intervening mountains serve as barriers to the Canadian air outbreaks and the flows from the Gulf of Mexico. Storms and weather fronts from the Pacific moving across the area during the winter lose much of their intensity and moisture west of the divide. As a result, flows from the Gulf of Mexico, strongest in the spring and early summer, produce most of the precipitation in the area. The cold outbreaks from Canada occasionally reach the area during the winter and provide the coldest extremes experienced in the area. Thunderstorms are occasionally observed, especially in the late spring and summer months.

Since the planning area is quite mountainous and isolated, limited climatic data are available from the planning area. Data from nearby locations are generally from valley sources. As a result, definition of the climatic patterns must depend upon an analysis of variations due to elevation and exposure characteristics of a given location in relation to available information. Although no weather station with complete summaries is near the area, nearby Bozeman, has fairly complete information. This is



AVERAGE ANNUAL PRECIPITATION

GALLATIN CANYON PLANNING STUDY

Figure I-4

presented where appropriate. Other data (see references) have been utilized where possible in the analysis.

Precipitation

In mountainous regions, precipitation may vary greatly from one location to another. Higher elevations generally receive greater amounts of precipitation; although, downwind sides of mountains may be in a rain shadow with amounts sometimes less than half of those observed on the upwind side. If the prevailing wind flow during precipitation periods is frequently from the same direction, these rain shadow areas become a consistent feature of the precipitation pattern. Summarized data is not available to determine if a consistent flow occurs during periods of precipitation in the area. However, a flow from the southeast to southwest is most likely with the direction modified locally by the terrain.

Precipitation data from the National Weather Service is limited primarily to valley sources, and indicates that yearly totals have an upper limit of a little over 20 inches in the area. It has been recognized that the snow water equivalent of the snowpack in the mountains and runoff has been considerably greater. The Soil Conservation Service (USDA) has analyzed the available snow survey data to develop a map of the precipitation amounts to be expected in the western half of Montana (including the planning area). Amounts to over 50 inches are projected at the highest elevations. It should be emphasized that the isohyets shown are based on a limited amount of data, extrapolated primarily from snow survey data. Amounts observed at a given location may vary considerable from that indicated due to local terrain effects including rain shadow areas. A discussion of the process utilized in the development of this map is included in Farnes (1971).

The mean total precipitation for Bozeman by month and year, and the greatest daily amount are presented in Table I-A. The lowest amounts occur in the winter months with the highest amount in June. This pattern is expected to exist in the valley floors under 6 to 7,000 feet, particularly in the Gallatin River valley. Above 6,000 feet, increased winter precipitation can be expected with the highest amounts during the winter months of December through February. At the highest elevations where annual amounts of over 50 inches of precipitation are expected, most of the annual amount will occur during the winter months, usually in the form of snow. No specific data is available, but amounts over 5 inches in 24 hours are probable.

Annual precipitation amounts at Bozeman between 1940 and 1969 varied from 11.30 to 23.64 inches with over 0.1 inch observed during every month.

Snowfall

As a result of the variation in the precipitation pattern snowfall amounts in the area can be expected to vary greatly. The mean and maximum monthly, greatest daily, and average annual amounts for Bozeman are presented in Table I-B. Although the annual mean amount of snowfall is 83.5 inches, the amount that

TABLE I-A

TOTAL PRECIPITATION
(inches)
Bozeman, Montana
(1940-1969)

Month	Mean	Greatest Daily
J	.94	.77
F	.68	.88
M	1.41	1.04
A	1.84	1.53
M	2.61	2.06
J	3.27	2.08
J	1.19	1.45
A	1.36	1.33
S	1.76	1.69
O	1.44	1.07
N	1.26	.91
D	.85	.88
Year	18.61	2.08

TABLE I-B

SNOWFALL
(inches)
Bozeman, Montana
(1940-1969)

Month	Mean*	Maximum Monthly	Greatest Daily
J	15.0	32.8	10.0
F	9.7	22.1	7.0
M	16.9	36.9	20.0
A	10.5	37.0	14.0
M	2.9	24.3	13.0
J	.3	6.0	6.0
J	0	T	T
A	T	1.0	T
S	.5	6.4	3.0
O	4.3	19.0	10.0
N	10.9	22.5	8.0
D	12.5	26.8	10.5
Year	83.5	37.0	20.0

*Period of record, 1945-1969

T-Trace, an amount too small to measure

accumulates on the ground should rarely exceed 20 to 40 inches. Above 8,000 feet the accumulation may be expected to reach 30 to 60 inches with amounts over 100 inches possible above 10,000 feet. It should be emphasized that amounts may vary considerably from one location to another - depending upon tree cover, exposure to wind, terrain effects including "rain shadows", and aspect (exposure to the sun). Generally, north slopes may expect less snowfall but the snow will persist longer, particularly where protected from strong winds. Only on-site observations and measurement may determine the conditions which exist at a given location.

Snow cover above 6,000 feet may be expected to remain until well into June. In most areas the snow depth most years will not decrease appreciably until May.

Temperature

The mean daily and monthly temperatures and the monthly extremes at Bozeman are presented in Table I-C. Summers are generally pleasant with average highs in the low 80°'s cooling off to about 50° at night. Winters are relatively cold with an average high in January of 30.7°F, and low of 10.1°F. The average temperature is below freezing during four months - December through March. During the 30 year period summarized, the temperature averaged below 10°F two of the months but did not average below 0°F during any month. Usually the coldest winter temperatures are associated with an outbreak of cold air from Canada coupled with nighttime radiation cooling. Mild mid-winter weather

TABLE I-C

TEMPERATURE
(°F)
Bozeman, Montana
(1940-1969)

	Means			Extremes	
Month	Daily Maximum	Daily Minimum	Monthly	Record Highest	Record Lowest
J	30.7	10.1	20.4	58	-36
F	35.8	15.8	25.9	62	-29
M	41.0	19.2	30.2	70	-23
A	63.7	30.4	42.1	81	2
M	63.3	38.5	50.9	89	16
J	70.2	44.9	57.6	91	26
J	81.5	51.1	66.3	98	32
A	80.3	49.4	64.9	99	29
S	69.5	41.5	55.6	95	16
O	58.7	33.4	46.1	82	9
N	42.4	21.9	32.2	70	-26
D	34.9	15.5	25.2	59	-29
Year	55.2	30.0	43.1	99	-36

is not unusual.

Although the summary for the given period (see Table I-C) indicates no temperatures over 100°F, a couple of temperatures over 100°F have been reported in previous years with one of 104°F having been verified. Lower elevations near Bozeman have reported slightly higher daytime temperatures and colder nights.

Temperatures in mountainous areas may vary considerably in short distances. Differences in elevation will result in average temperatures being about 3°F colder for each 1,000 foot increase in elevation. For example, since the Bozeman weather station is at 4,856 feet, temperatures at 7,000 feet can be expected to be a little over 6°F cooler at 7,000 feet than at Bozeman. This relationship can be expected to exist during breezy or cloudy periods. During calm, clear nights, radiation cooling may be expected in open areas having little tree cover. If the area is relatively flat, the air may become 20° to 30°F colder than nearby slopes. If the area is sloped, the cold air will flow downslope, collecting in flat areas and valley bottoms. A marked inversion results with the air 100 feet above the ground often 20° to 30°F warmer than near the ground. This area of cold air ponding tends to become foggy, especially if underlined by warmer water. It collects smoke or other pollutants released to the atmosphere from the area subject to the drainage flow. During sunny days, areas sheltered from the winds may become several degrees warmer, especially south facing slopes.

The first freeze in the fall at Bozeman usually occurs about September 12 with the last freeze in the spring about May 28, providing for an average growing season of 107 days. In areas subject to cold air ponding, freezing temperatures may occur during any month. On slopes away from the valley floors, longer freeze-free periods are to be expected.

Winds

No wind summaries are available from Bozeman. In mountainous regions like the planning area, winds at a given time will vary greatly from one location to another. High ridges and peaks may be windy. Canyons not oriented to the prevailing wind direction at a given time may have little wind. The prevailing flow in the area is expected to be westerly.

The strongest winds will be generally associated with weather frontal systems. Typically, southerly pre-frontal and northwesterly post-frontal winds will be strongest and most persistent, with the landforms reorienting these flows locally to the canyon orientation. These systems are strongest in the winter and spring months when winds to 50 to 60 mph may occur. Speeds over 70 mph are possible in mid-winter. The speeds on the high ridges and peaks may be even higher, but areas sheltered from a given flow may expect much lower speeds.

Occasionally during the winter, a "chinook" wind may be observed in the area. These winds are noted for the sharp temperature rises which accompany them. In this area, the chinooks are expected to be relatively mild with light to moderate winds.

Humidity and Clouds

Relative humidity data are not available for Bozeman. All data from other locations indicates that the early morning humidities should average in the high 70's (percent) most of the year. The lowest afternoon humidities in the winter will be in the 60's lowering to the lower 30's in the summer. High humidities to an uncomfortable degree are rarely observed.

Cloudy days are usually associated with the highest rainfall period. Because of the wetter winters in the high elevations, the winter period is the cloudiest period. Although it will vary somewhat in the study area, the Canyon is expected to have 60 to 70% of possible sunshine in the summer with 40 to 50% in the winter.

Severe Weather

Severe weather in the area is expected to be associated primarily with the winter storms or summer thunderstorms. Strong winds may be associated with weather frontal passages. During the winter these winds and falling snow may combine to form blizzard conditions. Higher elevations and valleys oriented north-south (especially the Gallatin River valley) are most exposed to these wind and precipitation conditions. Avalanching is possible on steep slopes subject to snow pileup at higher elevations.

Summer thunderstorms are quite common in Montana. Most of the state experiences 30 to 40 each year with more storms probable in the high mountains. Much of the late spring and summer rain is associated with these storms. They are most frequent in June through August, and may infrequently be associated with damaging hail and moderate to strong winds. Tornadoes develop infrequently with less than two per year reported in Montana, mostly in the eastern part of the state out of the planning area.

Implications for Development

While there are no significant climatic factors that would severely limit development, several conditions do exist that must be taken into account when planning for future development uses.

In the valleys at elevations under 6,000 feet, the highest monthly precipitation amounts occur during late spring and early summer. This heavy precipitation is often associated with thunderstorms. At higher elevations, the greatest precipitation amounts occur in the winter, usually in the form of snow. Snowfall is moderate in low elevations, but becomes quite heavy above 7-8,000 feet. Some areas may experience occasionally strong winds. Care should be taken in locating ski lifts, trams, and outdoor recreation activities. Blizzard conditions may occur requiring adequate snow removal equipment.

Temperatures in the summer feature warm days and cool nights, with freezing temperatures possible at higher elevations. Winters can be quite cold with temperatures in areas subject to cold air ponding falling to below -40°F on occasion. Outdoor activity and living facilities should avoid these areas. Residues from burning fuels (fireplaces, cars, etc.) collect near the ground on calm nights.

Thunderstorms are relatively common in late spring and summer. They may produce locally strong winds, hail, and high precipitation amounts in short periods. During these storms, lightning caused fires will occur in forested areas. Buildings should have adequate lightning protection.

Generally, development should utilize south facing slopes as living areas and for more sedentary outdoor activities. The north facing slopes might be utilized for ski facilities.

HYDROLOGY AND WATER QUALITY

Hydrologic Setting

The major drainage is the Gallatin River which bisects the study area and flows to the north. The Gallatin River has its headwaters within Yellowstone National Park. West of the Gallatin River the main tributaries are Spanish Creek, Hell Roaring Creek, Cascade Creek, Deer Creek, Dudley Creek, the West Fork Gallatin River, Beaver Creek, Buck Creek, Taylor Creek, and Sage Creek. On the east side of the Gallatin River the main tributaries are Squaw Creek, Swan Creek, Portal Creek, Porcupine Creek, Buffalo Horn Creek, Tepee Creek, Daly Creek, and Specimen Creek. None of these streams are intermittant. The Gallatin River flows in a northerly direction until it joins the Madison and Jefferson Rivers to form the headwaters of the Missouri River basin.

The Gallatin River watershed is generally mountainous with elevations ranging from less than 6,000 feet in the north end of the area to over 11,000 feet at Lone Mountain. The average discharge rate of the river is 756 cfs. A maximum discharge rate of 8,050 cfs was recorded on June 9, 1970. The river has a high mean flow relative to the drainage area it encompases. The high surrounding terrain has an average snowpack up to 100 inches each year, thus increasing the volume of water in this small drainage. Some of the principal streams in the study area provide a year-long source of water for agricultural and domestic needs.

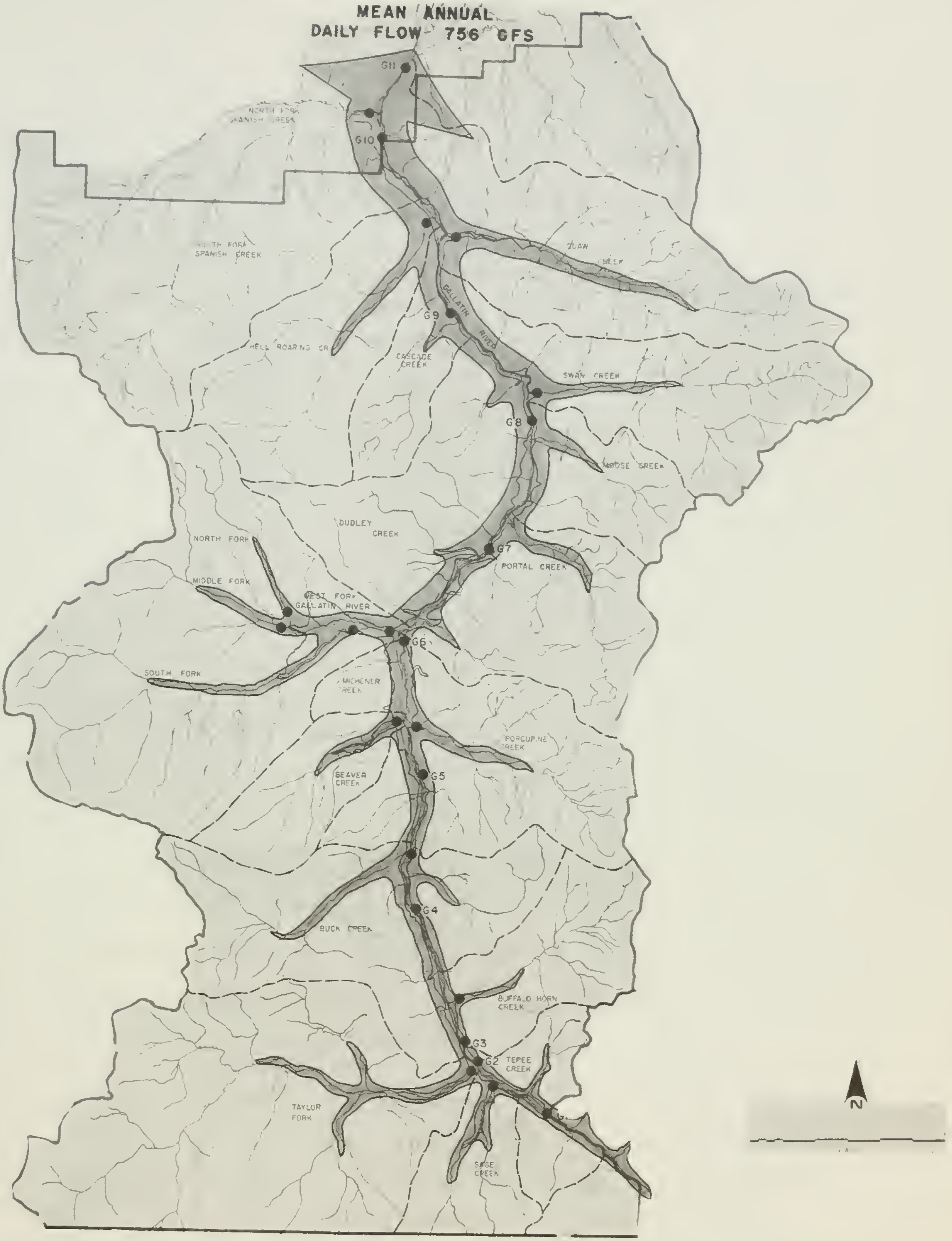
As reviewed previously, principal precipitation input to the Gallatin River hydrologic system comes in the form of snow or rainfall. The greatest percentage of the annual precipitation occurs during a three month period in winter (in the higher elevations). The valley floors receive their greatest percentage of precipitation during early summer (June). Melting snow contributes the greatest percentage of the annual runoff in the Gallatin River basin.

As surface runoff in the Gallatin Basin is influenced by snowmelt, peak runoff is delayed until midsummer. Surface runoff records are available for two stream gauging stations within the watershed located at Squaw Creek and Logger Creek. These stations are indicated by number on Figure I-5. Recorded peak runoff rated are presented in Table I-D.

Water Quality

Ground Water. Chemical and microbiological studies of ground water in the West Fork area of the Gallatin River basin have recently been conducted by the Montana State University Center for Environmental Studies. Information was gathered from 18 wells and 6 surface locations (located in Figure I-6) to obtain bacteriological and chemical characteristics for possible domestic water supply use in the West Fork area. Tables I-E and I-F present the bacteriological tests and their results at 12 of 18 wells sampled. The nutrient concentrations found in the ground water sources are presented in Table I-N.

Only one of the 12 wells tested was found to contain coliform organisms and fecal streptococci. This well is located near a



WATER RESOURCES

GALLATIN CANYON PLANNING STUDY

Figure I-5

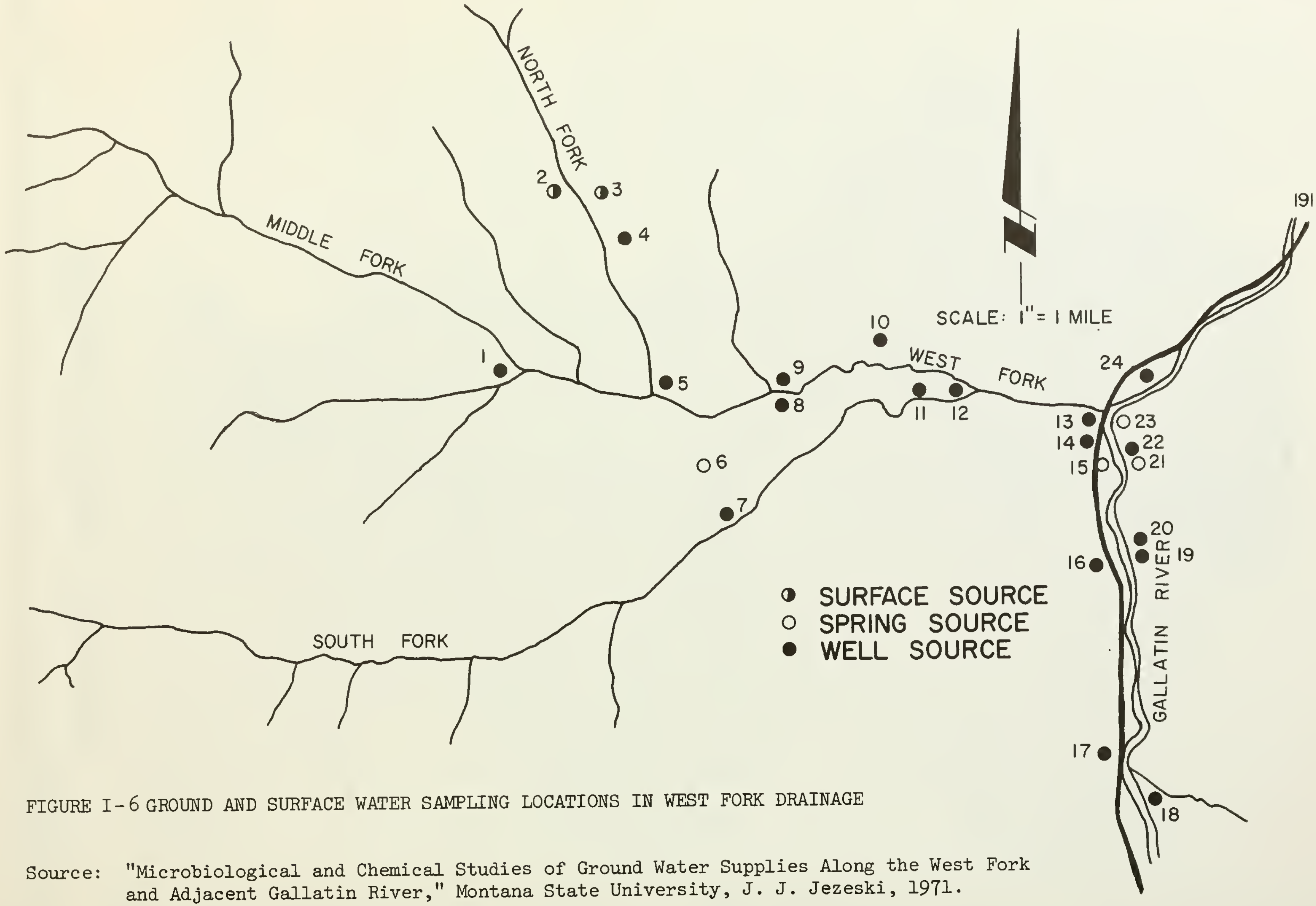


FIGURE I-6 GROUND AND SURFACE WATER SAMPLING LOCATIONS IN WEST FORK DRAINAGE

Source: "Microbiological and Chemical Studies of Ground Water Supplies Along the West Fork and Adjacent Gallatin River," Montana State University, J. J. Jezeski, 1971.

horse corral where inadequate drainage permitted runoff to enter the water table in the vicinity of the well. The occurrence of fecal streptococci in low numbers in the three surface springs is not a positive indication of human sewage contamination. Fecal streptococci are present not only in human feces but the feces of all warm blooded animals, including cattle, deer, bear, and elk. Many streams and unprotected springs in areas free of all human habitation will frequently contain fecal streptococci. Based upon existing data,most of the wells tested exceed the U. S. Public Health service standards for drinking water in terms of bacteriological quality. Disinfection may be required if the surface springs are to be utilized as a domestic water supply.

The nutrient concentrations, expressed individually as total phosphate (p), ortho-phosphate (p), ammonia nitrogen and nitrate nitrogen,were consistently below 1/2 mg/l. The nutrient concentrations are well below the minimum standards established by the U.S.P.H.S. drinking water standards.

The present quality of ground water in the West Fork area should be indicative of the whole canyon. To date, no comprehensive water quality sampling and analysis programs have been done for ground waters in other areas of Gallatin Canyon.

Surface Water. The quality of surface water for the Gallatin Canyon study area in general is quite good. Sample locations of 25 sites are illustrated in Figure I-5. A chemical analysis of these sample locations is presented in Table I-G. The water in the Gallatin River tends to be a moderately hard calcium bicarbonate type for those streams that drain sedimentary rock (Sage Creek, Taylor Fork, Buffalo Horn Creek, Buck Creek, and Beaver Creek). Streams that drain crystalline rock structures tend to be much lower in total dissolved solids (Swan Creek, Hell Roaring Creek, and Spanish Creek). Nutrient concentrations, such as total phosphate and ortho-phosphate, are probably reflections of the difference in geologic conditions and biologic activity throughout the watershed. Nitrate and ammonia levels were extremely low in all surface waters tested (presented in Tables I-H through I-K).

The relatively low total dissolved solids and low nutrient ion concentrations of surface waters in the Gallatin Canyon is in keeping with the oligotrophic (hydrographically young) condition of the Gallatin River and its tributaries. To prevent future biostimulation problems from occurring in the Gallatin Canyon, all future high density developments should provide adequate waste water treatment facilities in strict adherence to guidelines set by the Montana State Department of Health.

Specific surface water quality analysis for bacteriological information has been conducted by the Montana State University study for the West Fork of the Gallatin River. Figure I-7 illustrates the location of these sampling stations and Tables I-L and I-M present the results of laboratory analysis. The results of the microbiological tests revealed a wide variation in the number of coliform organisms and fecal streptococci. The number of coliform organisms varied at certain stations from 0 to 8,000, depending upon the day the sample was collected. However, wide variations such as these are typical of unpolluted surface streams. Also it should be noted that coliform counts less than 10,000 do not necessarily

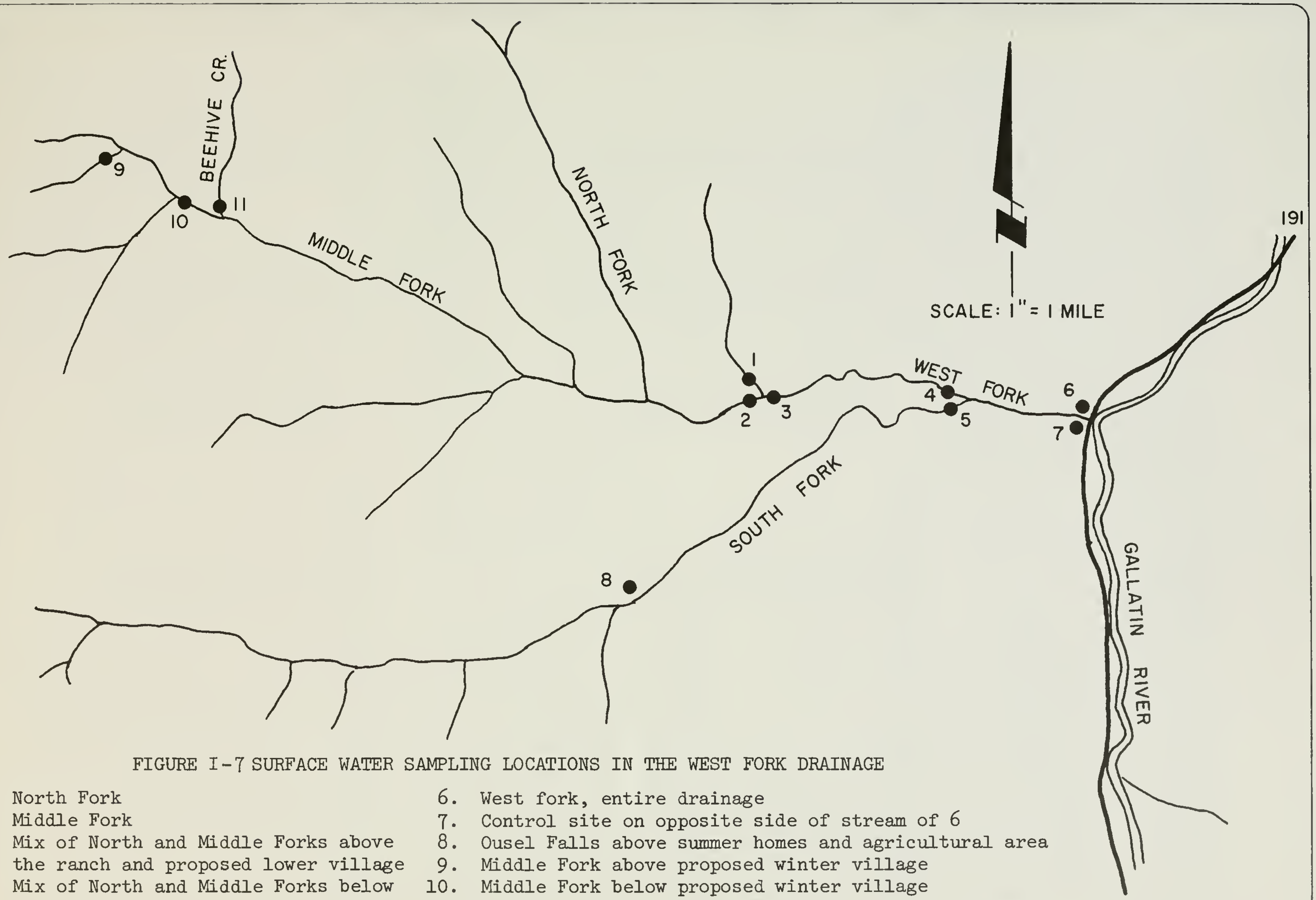


FIGURE I-7 SURFACE WATER SAMPLING LOCATIONS IN THE WEST FORK DRAINAGE

1. North Fork
2. Middle Fork
3. Mix of North and Middle Forks above the ranch and proposed lower village
4. Mix of North and Middle Forks below the ranch and proposed lower village
5. South Fork
6. West fork, entire drainage
7. Control site on opposite side of stream of 6
8. Ousel Falls above summer homes and agricultural area
9. Middle Fork above proposed winter village
10. Middle Fork below proposed winter village
11. Beehive Creek flowing from Spanish Peaks Wilderness Area

Source: "Ground and Surface Water Quality of the West Gallatin Canyon Area, Progress Report," Montana State University, 1970.

indicate agricultural or domestic pollution. All of the surface water sources tested fall within the permissible range stated in the U.S.P.H.S. drinking water standards.

Monitoring Programs. At the present time there are two water quality monitoring programs in the Gallatin Canyon study area--those being conducted for the MSU project and that of the Forest Service. The Forest Service program is confined to sediment sampling, stream flow gauging, and campground water testing. Under the MSU program, a three-year study of the West Fork area is being conducted to determine effects of development and operation of the Big Sky recreation project on water quality.

Implications for Development

The hydrology of the region is an aspect of the environment that is likely subject to adverse changes when development takes place. Extreme caution must be taken to avoid pollution of the surface streams and aquifers of the region.

More extensive records regarding the stream levels during the spring thaw are needed to adequately evaluate the safety of locating near the various streams.

Continuing utilization of ground water and surface water sources will be necessary to supply future developments in the Canyon. Water quality baseline parameters should be established for the entire study area, similar to the initial work conducted on the West Gallatin Canyon area by the Montana State University study team in 1970. A program such as this would establish existing criteria for water quality and would enable effective monitoring programs to be initiated.

TABLE I-D

RECORDED PEAK RUNOFF AT STATIONS IN THE GALLATIN RIVER* HYDROGRAPHIC UNIT

Squaw Creek Near Gallatin Gateway, Montana

Location--Lat 45°26', long 111°13', in SW 1/4 sec. 34, T.4 S., R.4 E., at private bridge, 10 miles south of Gallatin Gateway.
Drainage area--40.4 sq mi.
Records available--May 1959 to June 1969
Gage--Crest-stage gage installed May 5, 1959. Altitude of gage is 5,400 ft (from topographic map).
Annual maximum data--

Water year	Date	Gage height (ft)	Discharge (cfs)
1959	June 7, 1959	2.20	a 420
1960	May 12, 1960	1.66	147
1961	May 26, 1961	1.47	200
1962	June 13, 1962	1.34	168
1963	June 15, 1963	1.49	208
1964	June 8, 1964	1.44	195
1965	June 15, 1965	1.87	320
1966	May 6, 1966	1.08	136
1967	May 24, 1967	1.30	222
1968	June 30, 1968	2.02	560
1969	June 25, 1969	1.05	200

a=approximate

Logger Creek Near Gallatin Gateway, Montana

Location--Lat 45°27', long 111°14', in SW 1/4 sec. 28, T.4 S., R.4 E., at culvert on U. S. Highway 191, 10 miles south of Gallatin Gateway.
Drainage area--2.48 sq mi.
Records available--May 1959 to June 1969
Gage--Crest-stage gage installed May 5, 1959. Altitude of gage is 5,340 ft (from topographic map).
Annual maximum data--

Water year	Date	Gage height (ft)	Discharge (cfs)
1959	June 7, 1959	1.03	20
1960	May 12, 1960	.69	9
1961	May 26, 1961	.34	6
1962	June 13, 1962	.73	18
1963	May 27, 1963	.38	11
1964	June 8, 1964	1.09	25
1965	June 15, 1965	.66	18
1966	May 6, 1966	.08	5
1967	June 22, 1967	.50	16
1968	June 11, 1968	.93	24
1969	June 26, 1969	.66	17

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*Johnson and Omang (1969)

TABLE I-E

BACTERIOLOGICAL CHARACTERISTICS OF GROUND WATER SUPPLIES IN THE WEST FORK DRAINAGE*

Map Site No.	Lab Test No.	Type Source	Test Period from-to	Stand. Plate Count per ml			Coliform Counts per 50 ml			Enterococcus Counts per 250 ml		
				No. Tests	Min.	Max.	No. Pos.	Min.	Max.	No. Pos.	Min.	Max.
1	NT8	Well			Test well - chemical analysis only							
2	25A	Surface	9/8 - 10/31	5	220	1700	4/5	0	10	5/5	2	125
3	30	Open spring	9/8 - 10/31	5	140	5200	5/5	3	14	4/5	2	73
4	NT7	Well			Test well - chemical analysis only							
5	NT5	Well			Test well - chemical analysis only							
6	26	Covered spring	8/17 - 11/14	7	67	1400	5/7	0	82	7/7	1	1000
7	27	Well	8/17 - 8/31	2	3000	7100	0/2		0	0/2		0
8	NT4	Well			Test well - chemical analysis only							
9	NT6	Well			Test well - chemical analysis only							
10	31	Well	9/21 - 2/22	6	17	5000	0/6		0	0/6		0
11	32	Well	9/8 - 9/21	3	155	570	0/3		0	0/3		0
12	33	Well	10/31 - 3/7	2	35	2700	0/2		0	0/2		0

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*Jezeski and Weight (1971)

TABLE I-F

BACTERIOLOGICAL CHARACTERISTICS OF GROUND WATER SUPPLIES IN THE GALLATIN CANYON (BETWEEN PORCUPINE CREEK AND THE WEST FORK)*

Map Site No.	Lab Test No.	Type Source	Test Period from-to	Stand. Plate Count per ml No. Tests	Min.	Max.	Coliform Counts per 50 ml No. Pos.	Min.	Max.	Enterococcus Counts per 250 ml No. Pos.	Min.	Max.
13	36	Well	8/10 - 11/14	7	4	230	0/7		0	0/7		0
14	37	Well	8/10 - 9/21	3	54	700	0/3		0	0/3		0
15	41	Covered spring	8/17 - 10/31	2	Chemical analysis only							
16	40	Well	8/24 - 2/22	8	1	510	0/8		0	1/8	0	2
17	28	Well	8/17 - 2/22	7	360	2500	0/7		0	1/7	0	6
18	29	Well	8/17 - 10/17	5	36	430	1/5	0	15	1/5	0	28
19	35	Well	11/14	1		5100	0/1		0	0/1		0
20	34	Well	10/31 - 2/22	4	51	2500	0/4		0	0/4		0
21	39	Covered spring	8/10 - 11/14	7	30	1100	3/7	0	5	1/7	0	1
22	38	Well	8/10 - 1/6	7	11	1600	0/7		0	2/7	0	3
23	49	Open spring	10/31	1	Chemical analysis only							
24	42	Well	10/17 - 2/22	5	4	150	2/5	0	5	0/5		0

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*Jezeski and Weight (1971)

TABLE I-G

CHEMICAL CHARACTERISTICS OF SAMPLING STATIONS ON SEPTEMBER 14, 1970*

Name of Station	pH	Micro-mohos Conductivity	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride Acid (F)	Soluble Iron (Fe)	T.D.S.	
Gallatin River G-1	8.35	246	39.2	10.0	1.6	0.4	121.4	39.6	0.25	0.2	0.019	212.7	
Sage Creek	8.25	471	64.8	20.0	3.7	0.4	186.7	123.0	0.50	0.4	0.029	399.5	
Gallatin River G-2	8.40	285	48.0	11.8	2.3	0.8	128.8	49.4	0.25	0.2	0.020	241.6	
Taylor Fork Creek	8.40	289	47.2	8.5	10.6	0.8	153.2	36.0	0.75	0.2	0.050	257.3	
Gallatin River G-3	8.50	281	43.2	9.7	6.0	0.8	134.2	42.0	0.50	0.2	0.000	236.6	
Buffalo Horn Creek	8.50	276	41.6	11.8	10.6	1.8	187.3	14.2	0.50	0.2	0.000	268.0	
Gallatin River G-4	8.49	270	42.4	10.5	3.9	0.4	133.0	42.8	0.25	0.2	0.005	233.5	
Buck Creek	8.50	299	39.2	10.5	10.8	0.4	171.5	27.4	0.50	0.2	0.000	260.5	
Gallatin River G-5	8.50	283	44.0	10.2	4.1	0.4	124.5	52.0	0.25	0.2	0.030	235.7	
Beaver Creek	8.70	324	51.2	14.1	2.3	0.8	169.0	46.8	0.25	0.2	0.032	284.7	
Porcupine Creek	8.30	201	35.2	6.5	6.2	1.3	103.7	30.0	0.50	0.2	0.019	183.6	
Gallatin River G-6	8.30	430	69.6	20.0	4.4	0.8	140.3	145.0	0.75	0.5	0.000	381.4	
West Fork of Gallatin	8.40	246	40.0	7.8	3.7	0.4	117.8	39.2	0.25	0.2	0.030	209.4	
North Fork of West Fork	8.14	145	24.0	4.3	4.4	0.4	84.2	11.2	0.50	0.1	0.000	129.1	
Middle Fork of West Fork	8.27	145	35.0	8.2	0.9	0.4	88.5	9.8	0.25	0.1	0.000	143.2	
South Fork of West Fork	8.10	227	20.0	6.0	4.1	0.4	121.4	22.2	0.50	0.2	0.000	174.8	
Gallatin River G-7	8.42	301	46.4	11.8	4.4	0.8	132.4	63.6	0.50	0.1	0.009	260.0	
Gallatin River G-8	8.50	305	48.0	12.0	3.7	0.4	134.2	66.2	0.75	0.2	0.077	265.5	
Swan Creek	8.30	84	11.2	1.8	1.6	1.7	41.5	11.2	0.75	0.3	0.020	70.1	
Gallatin River G-9	8.32	289	48.0	11.5	3.9	0.7	122.7	64.4	1.00	0.3	0.000	252.5	
Hell Roaring Creek	8.42	78	9.6	1.3	0.7	1.2	20.1	18.0	0.25	0.1	0.001	51.3	
Squaw Creek	8.28	148	34.4	5.7	1.8	1.1	79.3	14.4	0.25	0.1	0.027	137.1	
Gallatin River G-10	8.53	266	46.4	9.5	3.7	1.2	105.6	56.0	0.75	0.3	0.000	223.5	
Spanish Creek	8.39	102	16.0	2.8	1.6	0.4	47.6	23.0	0.50	0.3	0.050	92.2	
Gallatin River G-11	8.50	240	39.2	8.3	3.2	1.2	102.5	46.2	0.50	0.4	0.011	201.5	
Average		249.2	39.4	9.4	4.2	0.8	118.1	43.7	0.5	0.2	,017	216.3	ppm

*Ground and Surface Water Quality of the West Gallatin Canyon Area (1970)

TABLE I-H

Surface Water Total-Phosphate Concentrations (mg/l PO_4-P)*

	8/9	8/17	8/31	9/14	9/27	10/10	10/25	Average for 1970
Gallatin G-1	0.062	0.040	0.053	0.038	0.089	.008	.025	.045
Sage Creek	.001	.005	.011	.012	.028	.005	.005	.010
Gallatin G-2	.050	.032	.046	.030	.064	.012	.012	.035
Taylor Fork	.001	.017	.026	.012	.035	.007	.000	.014
Gallatin G-3	.019	.023	.036	.021	.054	.014	.140	.044
Buffalo Horn	.100	.062	.128	.046	.100	.017	.025	.068
Gallatin G-4	.050	.033	.045	.030	.055	.010	.010	.033
Buck Creek	.049	.026	.036	.020	.048	.006	.035	.031
Gallatin G-5	.064	.031	.043	.030	.056	.012	.010	.035
Beaver Creek	.098	.021	.032	.020	.036	.073	.000	.040
Porcupine Creek	.121	.035	.045	.029	.077	.008	.010	.046
Gallatin G-6	.171	.021	.028	.016	.035	.006	.000	.040
West Fork	.116	.019	.017	.010	.027	.005	.000	.028
Gallatin G-7	.024	.026	.045	.020	.039	.006	.000	.023
Gallatin G-8	.046	.028	.036	.036	.035	.006	.000	.027
Swan Creek	N.S	0.116	0.160	0.108	0.145	0.033	.050	.102
Gallatin G-9	.067	.030	.036	.027	.040	.017	.011	.033
Hell Roaring Creek	.151	.006	.012	.006	.025	.006	.000	.029
Squaw Creek	.320	.075	.096	.069	.096	.019	.025	.100
Gallatin G-10	.062	.033	.048	.027	.043	.010	.005	.033
Spanish Creek	.159	.027	.037	.017	.036	.005	.000	.040
Gallatin G-11	.063	.030	.044	.029	.039	.006	.005	.031
North Fork	.023	.021	.016	.021	.026	.008	.005	.017
Middle Fork	.032	.029	.062	.014	.042	.007	.000	.027
South Fork	.025	.013	.030	.014	.022	.004	.005	.016
								Ave. .038

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* *Ground and Surface Water Quality of the West Gallatin Canyon Area*, (1970)

TABLE I-E

Surface Water Ortho-Phosphate Concentrations (mg/l PO_4-P)*

	8/9	8/17	8/31	9/14	9/27	10/10	10/25	Average for 1970
Gallatin G-1	0.022	0.015	0.006	0.120	0.032	0.021	0.040	.037
Sage Creek	.005	.000	.000	.016	.000	.000	.019	.006
Gallatin G-2	.020	.010	.010	.195	.015	.016	.024	.041
Taylor Fork	.012	.000	.000	.212	.000	.000	.005	.033
Gallatin G-3	.010	.019	.000	.034	.001	.011	.015	.013
Buffalo Horn	.039	.030	.024	.054	.027	.035	.037	.035
Gallatin G-4	.021	.010	.000	.034	.012	.015	.021	.016
Buck Creek	.011	.012	.000	.034	.012	.004	.012	.012
Gallatin G-5	.025	.008	.000	.049	.010	.012	.019	.018
Beaver Creek	.032	.000	.000	.047	.000	.000	.000	.011
Porcupine Creek	.045	.010	.001	.063	.007	.015	.005	.021
Gallatin G-6	.051	.003	.000	.079	.000	.000	.000	.019
West Fork	.045	.000	.000	.064	.000	.000	.000	.013
Gallatin G-7	.020	.000	.000	.068	.000	.000	.000	.011
Gallatin G-8	.022	.010	.000	.000	.000	.000	.004	.005
Swan Creek	N.S	.067	.057	.060	.060	.040	.069	.059
Gallatin G-9	.026	.004	.000	.001	.007	.061	.010	.016
Hell Roaring Creek	.050	.000	.000	.000	.000	.000	.000	.007
Squaw Creek	.094	.039	.037	.041	.038	.043	.039	.047
Gallatin G-10	.025	.016	.001	.000	.001	.007	.010	.009
Spanish Creek	.055	.001	.000	.000	.000	.000	.000	.008
Gallatin G-11	.027	.000	.000	.000	.001	.000	.001	.004
North Fork	.000	.000	.000	.000	.000	.000	.000	.000
Middle Fork	.007	.000	.000	.000	.001	.000	.007	.002
South Fork	.000	.000	.000	.000	.000	.000	.000	.000
							Ave.	.018

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*Ground and Surface Water Quality of the West Gallatin Canyon Area, (1970)

TABLE I-J

Surface Water Nitrate-Nitrogen Concentrations (mg/l NO_3-N)*

	8/9	9/17	8/31	9/14	9/27	10/10	10/25	Average for 1970
Gallatin G-1	.000	.004	0.018	.021	.000	.011	.020	.011
Sage Creek	.000	.000	.000	.0000	.000	.000	.000	.000
Gallatin G-2	.000	.003	0.011	.019	.000	.000	.000	.005
Taylor Fork	.000	.000	.009	.000	.000	.010	.000	.003
Gallatin G-3	.000	.000	.012	.000	.000	.004	.000	.002
Buffalo Horn	.000	.010	.019	.000	.000	.000	.000	.004
Gallatin G-4	.000	.000	.003	.000	.000	.000	.000	.000
Buck Creek	.000	.000	.001	.003	.000	.000	.000	.000
Gallatin G-5	.000	.000	.010	.000	.000	.002	.000	.001
Beaver Creek	.000	.000	.000	.000	.000	.000	.000	.000
Porcupine Creek	.000	.000	.000	.000	.000	.000	.000	.000
Gallatin G-6	.004	.011	.031	.023	.016	.019	.013	.017
West Fork	.005	.002	.012	.000	.000	.000	.000	.003
Gallatin G-7	.000	.000	.000	.000	.000	.000	.000	.000
Gallatin G-8	.000	.000	.000	.000	.000	.000	.000	.000
Swan Creek		.006	.009	.000	.000	.000	.000	.002
Gallatin G-9	.000	.000	.008	.000	.000	.000	.003	.002
Hell Roaring Creek	.025	.035	.045	.065	.040	.045	.050	.044
Squaw Creek	.000	.014	.022	.020	.012	.011	.003	.012
Gallatin G-10	.000	.013	.101	.000	.000	.000	.000	.002
Spanish Creek	.022	.016	.038	.090	.023	.018	.052	.037
Gallatin G-11	.000	.000	.010	.000	.000	.002	.003	.002
North Fork	.010	.019	.017	.000	.025	.020	.035	.018
Middle Fork	.000	.011	.002	.000	.000	.000	.000	.002
South Fork	.000	.008	.014	.000	.000	.000	.000	.003
								Ave. .007

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*Ground and Surface Water Quality of the West Gallatin Canyon Area, (1970)

TABLE I-K

Surface Water Ammonia-Nitrogen Concentrations (mg/l NH_3-N)*

	8/9	8/17	8/31	9/14	9/27	10/10	10/25	Average for 1970
Gallatin G-1	0.007	0.011	0.000	0.146	0.006	0.006	.008	.026
Sage Creek	.006	.018	.008	.000	.000	.000	.000	.005
Gallatin G-2	.005	.007	.000	.030	.000	.000	.000	.006
Taylor Fork	.005	.006	.009	.025	.011	.020	.000	.011
Gallatin G-3	.000	.020	.007	.009	.007	.005	.000	.007
Buffalo Horn	.005	.006	.000	.000	.000	.000	.000	.002
Gallatin G-4	.000	.017	.000	.062	.015	.000	.000	.013
Buck Creek	.006	.015	.000	.009	.000	.000	.000	.004
Gallatin G-5	.006	.020	.005	.034	.000	.000	.000	.009
Beaver Creek	.000	.025	.007	.000	.000	.000	.000	.005
Porcupine	.000	.030	.006	.008	.020	.000	.000	.009
Gallatin G-6	.005	.020	.000	.020	.000	.000	.000	.006
West Fork	.000	.025	.006	.006	.000	.000	.088	.018
Gallatin G-7	.005	.018	.007	.010	.006	.000	.000	.007
Gallatin G-8	.000	.000	.008	.000	.008	.000	.000	.002
Swan Creek		.010	.000	.000	.000	.012	.000	.003
Gallatin G-9	.005	.000	.004	.000	.006	.000	.000	.002
Hell Roaring Creek	.005	.000	.000	.000	.009	.010	.000	.003
Squaw Creek	.006	.000	.000	.000	.015	.005	.000	.004
Gallatin G-10	.007	.006	.007	.000	.000	.000	.000	.007
Spanish Creek	.007	.006	.000	.000	.000	.000	.000	.002
Gallatin G-11	.006	.000	.000	.000	.000	.000	.000	.001
North Fork	.010	.020	.011	.000	.000	.000	.000	.006
Middle Fork	.006	.025	.000	.000	.000	.000	.000	.004
South Fork	.005	.030	.000	.000	.000	.000	0.110	.021
								Ave. .007

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*_Ground and Surface Water Quality of the West Gallatin Canyon Area_, (1970

TABLE I-L

ARITHMETIC MEANS AND RANGES OF BACTERIA PER ML (STANDARD PLATE COUNT) AND OF TOTAL COLIFORM AND ENTEROCOCCAL BACTERIA (MEMBRANE FILTER COUNTS).* LOCATIONS OF SITES SHOWN IN FIGURE I-7

Site		No. of Tests	Bacteria/ml			Coliforms/100 ml			Enterococci/100 ml		
			Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
1	6/11/70-2/22/71	29	580	25	1,600	42	0	190	26	0	420
2	6/17/70-2/22/71	28	1,800	250	6,800	84	0	320	19	0	65
3	6/11/70-2/22/71	25	1,200	25	3,700	72	0	190	24	0	210
4	6/11/70-2/22/71	25	4,200	44	21,000	650	0	8,000	37	0	210
5	6/17/70-2/22/71	28	2,600	120	43,000	47	0	200	26	0	340
6	6/11/70-2/22/71	29	2,900	60	35,000	260	0	3,600	29	0	250
7	6/30/70-7/20/70	7	2,500	410	4,500	1,600	10	5,600	25	8	40
8	7/13/70-9/25/70	12	1,700	190	14,000	89	10	370	22	2	77
9	7/27/70-9/25/70	9	490	70	1,500	180	10	1,100	33	6	69
10	7/27/70-9/25/70	9	1,700	260	3,000	240	0	900	25	5	50
11	7/27/70-9/25/70	9	1,500	30	7,600	82	40	260	22	5	47
		210									

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*Johnson and Omang (1969)

TABLE I-M

PERCENTAGES OF DIFFERENTIATED COLIFORMS*
LOCATIONS OF SITES SHOWN IN FIGURE I-7

		Fecal coliforms		E. coli		E. aerogenes		Intermediates	
Site	No. of organisms tested	No. of organisms	%	No. of organisms	%	No. of organisms	%	No. of organisms	%
1	32	9	23	11	34	10	32	11	34
2	58	14	24	13	22	1	2	44	76
3	52	25	48	20	38	4	8	28	54
4	53	24	45	26	49	2	4	25	47
5	32	15	47	9	28	2	6	21	66
6	58	18	31	17	29	10	17	31	54
7	14	6	43	8	58	3	21	3	21
8	16	7	44	7	44	0	0	9	56
9	13	6	46	7	54	1	8	5	38
10	21	7	33	10	48	3	14	8	38
11	14	1	7	1	7	2	14	11	79
Total	363	132	36	129	36	38	10	196	54

---

*Johnson and Omang, (1969)

TABLE I-N

NUTRIENT CONTENT OF WELLS AND SPRINGS (mg/l)*

Map Site No.	Wells	# Samples	Total PO_4-B	Ortho PO_4-P	NO_3-N	NH_3-N
13	B.S.	4	0.057	0.000	0.053	0.002
14	Ch.	3	0.008	0.000	0.064	0.002
20	C.W.	2	0.019	0.003	0.021	0.007
7	M.W.	3	0.018	0.000	0.225	0.049
8	NTS4	1	0.018	0.000	0.410	0.032
18	Po	4	0.015	0.000	0.025	0.030
17	OP	3	0.017	0.000	0.121	0.016
16	BT4	3	0.042	0.016	0.000	0.283
9	NTS6	1	0.004	0.000	0.177	0.000
4	NTS7	1	0.027	0.000	0.340	0.000
11	Ro	2	0.018	0.000	0.012	0.002
12	Sm	1	0.008	0.000	0.013	0.005
22	Cr	1	0.000	0.000	0.080	0.000
5	NTS-5	1	0.043	0.025	0.090	0.000
1	NTS-8	1	0.017	0.003	0.014	0.000
	Average		0.035	0.003	0.104	0.019
	Springs					
2	C.S.	4	0.071	0.044	0.103	0.001
6	M.S.	4	0.223	0.106	0.072	0.011
15	V.S.	1	0.020	0.000	0.006	0.025
3	LMR	2	0.045	0.000	0.017	0.003
	Average		0.105	0.050	0.060	0.012

*Ground and Surface Water Quality of the West Gallatin Canyon Area, Progress Report, (1970)

VEGETATIVE PATTERNS

Commercial Forest Areas

The commercial forest areas are predominately found at the mid-elevation range of the study area. Principal stands found here are pure lodgepole pine or mixed lodgepole pine, and Engelmann spruce - subalpine fir and Douglas fir. These stands are typically of saw-timber size of sufficient quantity and location as to constitute an important timber resource.

Some of the areas officially designated commercial forest type are unsuitable for commercial use due to excessively steep topography, soil instability and proximity to streams and heavy recreational use areas.

The following sections summarize the silvics (conditions of growth) for the principal stand types. This information has provided a basis for many of the recommendations made in the latter part of this report.

Lodgepole Pine

Growth Conditions. Extensive stands are found where annual precipitation is 18" or above with the best development conditions occurring in areas where precipitation reaches 21" or more.* In the Gallatin area these stands are found between 5,200

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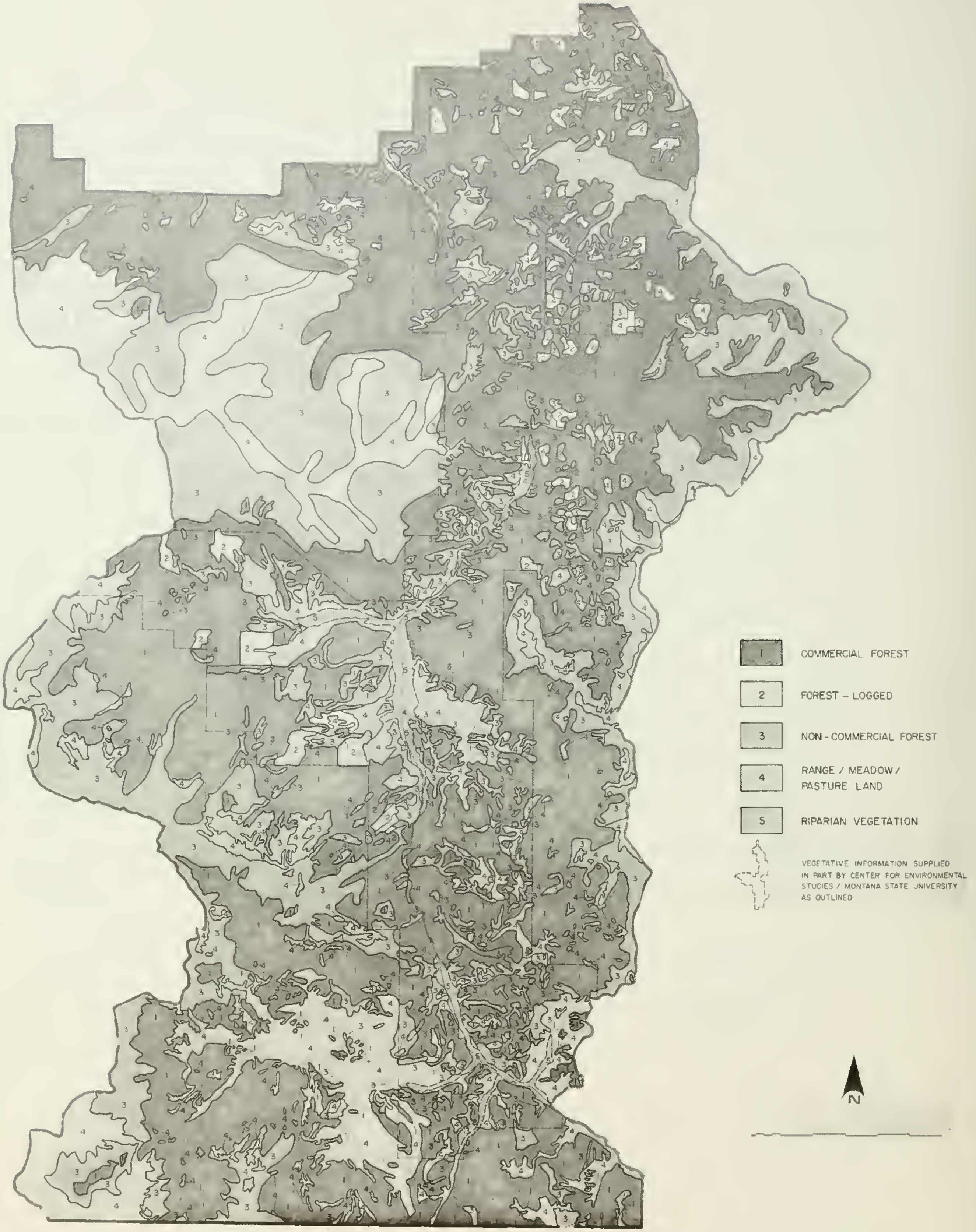
*Silvics of Forest Trees of the United States (1965)


1 COMMERCIAL FOREST
2 FOREST – LOGGED
3 NON-COMMERCIAL FOREST
4 RANGE / MEADOW / PASTURE LAND
5 RIPARIAN VEGETATION
VEGETATIVE INFORMATION SUPPLIED IN PART BY CENTER FOR ENVIRONMENTAL STUDIES / MONTANA STATE UNIVERSITY AS OUTLINED
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VEGETATIVE PATTERNS

GALLATIN CANYON PLANNING STUDY

Figure I-8

and 8,500 feet and generally grow better on northern and eastern aspects with gentle slopes or in the flatter areas. The soils of this area are generally marine clays, shale and sandstones.

Seeds are produced virtually every year, with abundant crops at one to three year intervals. The serotinous or closed cone habit is widespread in the lodgepole of this region. These cones remain closed until temperatures reach 113°F and may be triggered by fire or solar radiation. Germination of viable seed occurs in the spring under temperatures between 47° and 78°. The ideal seed bed for this species is in mineral soil or disturbed duff free of competing vegetation and with a high percentage of sunlight. Wind is not important in dispersal except when cones are predominately non-serotinous. Serotinous seed quantities capable of restocking are seldom scattered beyond 200 feet from the parent trees. Seed from cones attached to slash and from cones knocked from slash and scattered over the forest floor are important sources of seed. Seed release from this source takes place after the first year of cone exposure with some further release for as long as six years or more.

The most serious insect damage to lodgepole pine has been attributed to the mountain pine beetle (Dendroctonus ponderosae) which generally attacks the healthier trees eight inches in diameter and larger. A second beetle of lesser significance is the lodgepole pine beetle (Dendroctonus murrayanae) which generally only attacks the older and weakened trees at the base. It can become a problem along the margins of old-growth cuttings because of its habit of building up in freshly cut stumps.* Other insects of secondary importance are: the spruce budworm (Choristoneura fumiferana), the lodgepole terminal weevil (Pissodes terminalis), the lodgepole sawfly (Neodiprion burkei), and the lodgepole needle miner (Recurvaria milleri). Principal diseases are dwarf mistletoe (Arceuthobium americanum) and the comandra rust (Cronartium comandrae) both of which are widespread on lodgepole pine. Other common diseases are: Western gall rust (Cronartium harknessi), and the heart rot fungi, Fomes pini and Stereum pini.

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*Silvics of Forest Trees of the United States, (1965)

Engelmann Spruce - Subalpine Fir Association

Extensive stands of this association are found where annual precipitation varies from 20 to 35 inches. This association is found at elevations of from 5,000 to above 8,000 feet, with nearly pure stands of subalpine fir found in the upper reaches. Here it forms the major timberline forest where it may be found associated with white bark pine and limber pine. The lower elevation mixed stands are normally found along the colder stream valleys and in cold, moist basins. The best growth occurs on moderately well drained silt, clay loam or alluvial soils with an accessible water table. Soils wet or too dry for Engelmann spruce will frequently support subalpine fir.

Engelmann spruce begins bearing cones between the ages of 16 and 25 years and bears good seed crops from every two to six years. Subalpine fir normally bear seed after reaching 20 years, producing good crops on the average of every three years. In

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Engelmann Spruce Regeneration Practices in the Rocky Mountains, (1970) the Gallatin area Engelmann spruce is not rated as a prolific seeder. In one study, 2 good, 4 fair and 15 poor crops were recorded during a 21 year period. Studies have shown effective seed dispersal distances up to 660 feet from the parent stand, although the average distance is much less than this.

Other studies in the Intermountain Region shows that an effective seeding distance of 660 feet is possible on northerly aspects if the bordering seed trees approach 200 feet in basal area per acre. Effective seed dispersal distances on the harsher south aspects may be as low as 260 to 400 feet for the same basal area of seed trees. For a lesser seed source of 70 square feet of basal area, effective seed dispersal may be as low as 0 to 200 feet on northerly aspects and 0 on other aspects. The effective dispersal distance is dependent upon the amount of seed present and the length of time a favorable seedbed exists.*

Germination is usually good on mineral soil and burned seedbeds where moisture is adequate. The natural forest floor or litter is generally a poor seedbed. Engelmann spruce will survive at lower light intensities than lodgepole pine, but cannot survive deep shade as well as its close associate subalpine fir; the same conditions hold true for its resistance to low temperatures. Engelmann spruce is less resistant to drought than its associates, and its shallow and slow growing root system causes the seedlings to be susceptible to high temperatures.

The Engelmann spruce-subalpine fir type forms a stable or near-climax forest vegetation throughout much of the area it occupies. Following destruction by fire, or insect attack on northerly exposures, this type usually returns immediately. On southerly exposures, such species as aspen, Douglas fir, and lodgepole pine may become established initially but are eventually replaced by the more shade-tolerant spruce and fir.* The thin bark and persistence of lower limbs makes both species especially susceptible to destruction or injury by fire.

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*Engelmann Spruce Regeneration Practices in the Rocky Mountains, (1970)

Both species are extremely shallow rooted and thus are susceptible to windthrow. This is particularly true in mature and over-mature stands which have been partially cut.**

The Forest Fire of 1880. "Scientific surveys in the Gallatin Canyon regularly reckon with the great fire of 1880 which destroyed much of the forest for some forty miles, altered the pattern of wildlife for many years, and also destroyed remains of human habitation which would have provided landmarks for early inhabitants. Fortunately the forest restored itself in record time, and the uniform growth provides one of the features of its beauty ninety years later."***

For a complete account of logging operations in the Gallatin Canyon, the reader is referred to Burlingame, p. 11, 1970.

Management of Forest Lands

The Gallatin Canyon study area boundaries lie totally within the Gallatin Ranger District of the Gallatin National Forest. Management of national forest lands in the Canyon is governed by the Multiple Use-Sustained Yield Act passed by Congress in June, 1960. This mandate for the management of forest land gives broad directives under which the Forest Service manages these lands for outdoor recreation, range, timber, watershed, and wildlife and fish purposes.

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* _Silvics of Forest Trees of the United States_, (1965)

** _Engelmann Spruce Regeneration Practices in the Rocky Mountains_, (1970)

*** Burlingame, (1970)

Each region within the national forest system has prepared a Multiple Use Management Guide in reference to this Act. This regional guide describes the management situations for the various resources and activities, and sets forth basic assumptions. Each region is divided into a number of multiple use management zones for which the Regional Guide states the management direction and established coordinating requirements. These regional zones are based upon land characteristics and capabilities, plus existing and potential resource uses and activities. The management zones are described in the "Regional Setting" portion of this report.

A Ranger District Multiple Use Plan is also prepared within the same framework as the Regional Guide. This plan however, specifically defines the Management Units within each of the regional zones in terms of geographic locations and land characteristics on the Ranger District. The District Ranger bears the responsibility of implementing these regional objectives at the local management level.

The individual management units as established by the Gallatin Ranger District are suggested for continued use. The advantage of utilizing the management units as established by the Ranger District is that specific information acquired through Forest Service efforts may be used as input into the assessment of future land uses. Since the national forest lands comprise the majority ownership within the study boundaries, this utilization would be of significant value.

National Forest Lands. The public forest management activities in the study area have been widely diverse but compatible with most all uses. Timber values have not been over-emphasized and commercial timber operations have cause for little criticism under the present management goals. This is not to say that future interpretations of the management goals and the means used to achieve them could not create problems incompatible with the public desires.

The zone and unit management situations and decisions are clearly stated in the "Multiple Use Management Guide" prepared by the Gallatin Ranger District and reflect sound judgement in assessing the necessary management implementations. The problem that always arises is that of securing the necessary staff and funding to carry out all decisions. Forest conditions are certainly not static and new problem situations often require alteration of annual management action plans and sometimes revision in long term goals for any particular management unit.

The Gallatin Ranger District encompassed 449,641 acres in 1965 of which 339,214 acres were in National Forest lands. Timber harvesting produces a moderate income and constitutes little impact upon the landscape aesthetics at present. Between 1954 and 1965 the annual cut of Lodgepole pine on National Forest lands within the district varied between 6 and 7 million board feet, while the lesser acreage of private lands produced approximately an equal amount. At the present time the annual cut has been reduced downward to approximately 3 million board feet at which level it is anticipated to remain for the next several years. This would include any feasible salvage and sanitation cuts which may be necessary to maintain the watershed in a satisfactory condition. Almost all of the logging is taking place in overmature and decadent lodgepole pine stands, that are common in the district as well as the region.

Stumpage values for lodgepole pine in the district have varied considerably the past few years, from a low of $1.90 per thousand board feet upwards to a high range of approximately $18.00 this current year. While these ranges probably reflect considerable differences in development, logging and transportation costs, they also reflect considerable increases in the lumber market conditions, that are subject to extreme fluctuations. In the more remote areas, where present timber management problems often predominate, the current lumber market dictates whether a timber sale is economically feasible and hence may economically permit salvage operations and stand improvements where they are sorely needed.

Private Lands. Burlington Northern, Inc. is the largest single land owner within the Gallatin Ranger District, controlling at present approximately 68,500 acres in the study area. None of their lands have been intensively developed and incomes have been realized through timber harvest and permit grazing only.

The company does not directly engage in the timber harvesting of their lands but allows the timber purchaser (currently Yellowstone Pine Company) to contract the logging as needed. The contract now in effect allows Yellowstone Pine Company to harvest by area over specified sections of land but does not provide Burlington Northern any control as to the method of harvest, size of clear-cut units, location of units (specific), or logging specifications to be utilized by the purchaser or contractor. This contract will expire in 1976 at which time Burlington Northern will adopt contract specifications that will guarantee them full control of timber harvesting procedures in the future. The annual cut is progressing at the rate of approximately five million board feet per year and will probably continue at about this rate for the duration of the contract.

Regeneration of reproduction on the logged units has not been a problem where slash disposal has been accomplished, but it is becoming a problem where slash disposal has not been completed because of previously inadequate bonding fees for this purpose.

Effective July 1, 1971, the State Legislature authorized the fee for slash disposal to be increased from $1.00 per thousand to $2.00 per thousand. The bond being collected for logging now being done on private lands in the study area has been at the rate of $2.00 per thousand since July 1. Negotiations are now underway between the State Forester and the Burlington Northern which, when completed, will result in the Burlington Northern disposing of the slash from logging operations on their lands. In the event this agreement is not made, the State will continue to do the hazard reduction work.

It should be recognized here that the State Hazard Reduction and Management Law provides only for the reduction of fire hazard associated with the accumulation of logging slash and no provision is made for slash disposal to standards satisfactory for securing natural regeneration. Hence, the landowner must complete slash disposal and provide the necessary seedbed preparation at an additional cost or if he so decides, not at all.

Timber Harvest Techniques/Alternatives

It is necessary to recognize that the ecological requirements of each tree species differs as well as the individual stand and site conditions. Management objectives for the land must dictate the direction silvicultural methods are to be applied in timber harvest. These objectives are necessarily aligned to the perpetuation of the important tree species, most of which are seral or subclimax and would under natural conditions be replaced by less desirable species, precluding instances of fire or other major disturbances. In the Gallatin Canyon area, lodgepole pine is the seral species which is managed for its commercial values and, consequently, the management objectives must be oriented with the silvics which assure its perpetuation in predominance to other tree species.

Many of the overmature lodgepole stands have been damaged by both insects and disease and in some cases are being replaced naturally from within the stands by the more shade tolerant subalpine fir and Engelmann spruce. To assure conversion of these decadent stands into productive young stands of lodgepole pine, an even age management approach through the clearcut method of harvesting has been applied. Silvicultural prescriptions have utilized clearcutting as the major tool for satisfying these needs in the past and should continue to be used in the future although some modifications in applications, particularly on low-yield sites, may be in order.

Two immediate problems facing the forest resource managers in the Gallatin Canyon Study Area are controlling the dwarf mistletoe infections and the mountain pine beetle infestations. The majority of lodgepole pine stands are infected with dwarf mistletoe and comandra blister rust to some degree and many stands have been severely weakened, affording the opportunity for an epidemic of the mountain pine beetle in the Canyon. Current surveys of the present beetle infestations indicate that the problem is severe and control measures are needed immediately to prevent a possible major epidemic in the Gallatin Canyon.* Hence, the priority of management must be toward obtaining early control of both the insect and disease problems. These needs are recognized by the U.S. Forest Service, State Forester, and Burlington Northern; but implementation of controls are limited by available budget and present inaccessibility to some of the problem areas. Precluding immediate salvage of the damaged stands, the merchantability of pine is usually lost to boring insects and fungus stains after the first year following mortality.

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*State of Montana (1971)

From a biological standpoint, the most effective and economical means of initiating control measures for dwarf mistletoe is through clearcutting of the infection centers. This practice is economically and biologically desirable in the high-yield lodgepole pine stands, but is not a desirable practice for stands in areas receiving current heavy recreational use. Some compromise measure will probably be required in these cases, viz. selective cutting of trees with advance trunk infections and thinning to improve growth characteristics and individual tree vigor. Although this approach will not prevent the reoccurrence and spread of dwarf mistletoe infections, it may provide a more resistant stand in terms of beetle susceptibility and tree longevity and still permit the continued recreational use of the area.

The feasibility and development of alternative control methods in recreation areas requires considerably more research before any proven methods can be utilized with any assurance of effectiveness.

It is apparent, based upon the economics, silvicultural requirements and the prevailing pathological conditions characteristic of the lodgepole pine stands in the Gallatin Canyon Study Area, that the initial harvest cut of mature and overmature stands can be most advantageously accomplished by clearcutting provided due consideration is shown toward the other multiple uses.

Under different stand conditions, the use of other even age silvicultural practices in the management of lodgepole pine may be more desirable for a particular management unit. The seed-tree method and shelterwood methods of harvesting may be more compatible with additional uses of the forest, particularly recreation.

Shelterwood cuttings create much less impact upon the environment and aesthetic values than clearcutting. However, it would substantially alter the species composition in old growth stands where Engelmann spruce and subalpine fir dominate the understory.

It is of interest here to point out that the U. S. Forest Service Study team, in their study of the forest management practices in the Teton, Bridger, Shoshone, and Bighorn National Forest,* suggest that "selection cutting, even in lodgepole pine stands heavily infected with dwarf mistletoe, can be the most practical method (of timber harvesting) where management objectives other than timber production are foremost." The critical problem is the determination of the minimum level of partial cutting needed to assure regeneration by lodgepole pine.

As management alternatives in harvesting methods, the U. S. Forest Service study team has suggested the following cutting prescriptions (quoted in full text):

> "We believe that a light selection cutting, particularly on the low-yielding timber sites, should be considered a valid management alternative. Such harvest would remove some mature trees, and the method might best be classified as "pussyfoot logging" because the logger would leave few tracks. We envision no permanent roads, no site preparation for regeneration, and minimal slash disposal. This harvest method would have little or no detrimental impact

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*Forest Management in Wyoming (1971)

> on the environment. It would help to maintain or improve the vigor of the stand, and it would make available to industry raw material that would otherwise be lost to decay."
>
> "On a somewhat larger area of high-yield timberland, we believe the Forests should try some combination of selection cutting and sanitation salvage--the harvest of dead and dying trees. Neither of these methods may be economic individually, but with some imagination they could be included in timber sales calling for small clearcuts. For example, clearcuts of 5 to 10 acres might serve as yarding areas for selective or sanitation and salvage logging in the surrounding area. Although marginal economically, this type of logging makes the stand more vigorous and productive. Periodic thinning throughout the life of a stand will recover most of the wood that otherwise dies or rots (about one-third of total production). This system might offer an opportunity to reduce acreage of new clearcutting until much of the already cutover land develops into thriving young stands of replacement timber."*

The use of selective cutting would appear appropriate for management units where anticipated use for recreation, and current recreation pressures, outweigh the commercial values of the forest. In other management units where the timber value is relatively good and recreation pressures are secondary, clearcutting in lodgepole pine should be continued. This should be done with some modifications in size, design, and logging requirements for the protection of other uses.

The choice of timber harvest areas should be based upon relevant criteria for weighing resource values against land use alternatives. The timber values bear close scrutiny and should realistically reflect the actual cost requirements for slash disposal to standards compatible with other uses of the land.

Prescribed Burning and Slash Disposal

Fire as a practical tool in forest management has been used in the past and should continue to be used in forest management.

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*Forest Management in Wyoming (1971)

This is particularly true in the northern Rocky Mountain forests where fire has been a major regulator in the natural selection of existing forest types prior to the advent of managed forests.

The danger today is that overreaction to air pollution may remove the tool from the land manager's hands. Smoke emissions from prescribed burns can be controlled and directed away from sensitive areas when conducted under proper atmospheric conditions. The adoption of severe restrictions to the point of prohibition of open burning, however, will most certainly end with catastrophic results.

This problem has been studied intensely the last two years by a task force consisting of a silviculturist and ecologist, a forest fire researcher, a wildlife ecologist, and a specialist on wilderness. This task force was appointed by the Missoula Chapter of the Society of American Foresters and the published conclusions and recommendations* have been endorsed by the Northern Rocky Mountain Section of the Society of American Foresters. Some excerpts are cited here to emphasize the need for continuing with the practice of open burning under controlled conditions.

> "In a year, an acre of forest converts solar energy into vegetable matter equivalent to 300 gallons of gasoline. This growing reservoir of energy is stored as organic matter until it is converted, through oxidation, to more stable forms. Regional climate and weather predispose the complex organic molecules resting in vegetative systems to rapid reduction of their energy level via fire."
>
> "By extinguishing wildfires, man merely postpones the inevitable release of energy stored through photosynthesis. The more energy is accumulated the greater are chances of a subsequent wildfire. Also, because the organic bank balance is constantly growing, later wildfires are often more destructive than the one which was extinguished."

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*Fire and Forestry in the Northern Rocky Mountains (1971)

To emphasize the intensity and futility of combating the forces of wildfire where fuels have accumulated, the following paragraph has been cited from a recent article on fuel buildup in American forests.

> "Idaho's Sundance fire, September 1, 1967, made a spectacular run of 16 miles in nine hours, claimed two lives, threatened several communities, and destroyed more than 50,000 acres of valuable timber and watershed. Anderson estimated that at one point the fire was releasing thermal energy of nearly 500 million BTU per second, which is equivalent to a 20-kiloton nuclear bomb exploding every 2 minutes. A mobilized force of several thousand men combined with favorable weather were needed to stop this fire."*

The point which is to be stressed is that without the opportunity to dispose of excess fuels in the future, a forested watershed with the exceptional esthetic qualities of the Gallatin Canyon watershed could easily be devastated by a few occurrences of inevitable wildfire, that burns without regard for prohibitive legislation or scheduled smoke emissions.

The major categories of use of prescribed fire in forest management are in (1) fire hazard reduction, and (2) seedbed preparation, both for natural and artificial tree regeneration.

Alternatives to Prescribed Fire

> "What alternatives are available to accomplish the jobs of seedbed preparation and wildfire hazard reduction?
>
> The following tabulation lists some of the operations that can be used to accomplish these jobs. In many instances, more than one operation is required to accomplish the seedbed preparation and slash disposal possible with one prescribed burn."

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* Fire and Forestry in the Northern Rocky Mountains (1971)

Operation	Accomplishment	
	Seedbed preparation	Slash disposal
Dozer pile and burn	X	X
Lop and scatter slash	-	X
Dozer with shearing blade	X	X
Trenching, discing, and furrowing	X	-
Terracing	X	-
Chipping slash	-	X
Machine scalping	X	-
Hand scalping	X	-
Application of silvicides	X	-
Increased fire protection	-	-

> "In reality there are no complete alternatives to the use of fire in vegetational management. Most of those listed accomplish only part of the job and often must rely on fire for disposal of debris. Others dispose of slash and reduce fire hazard, but they accomplish little or no site preparation. Some disadvantages of alternatives are: (1) the use of heavy equipment results in undesirable soil compaction and drastic reduction of the water infiltration rate; (2) the use of heavy equipment is limited to slopes under 30 to 35 percent; (3) practices such as terracing, trenching, and furrowing are aesthetically undesirable and are unacceptable to the public; and (4) compaction of slash by drum cutters removes the opportunity for good seedbed preparation, especially in heavy slash, and costs are often nearly prohibitive."
>
> "Foresters are still searching for an ideal process which will remove the risk of wildfire, prepare a good seedbed, dispose of the fuel accumulation, enhance site quality, and, at the same time, meet with the approval of all users and the public. When properly and intelligently applied, prescribed fire still ranks highest among the options available to forest land managers in the northern Rocky Mountains."*

Implications for Development

The complete vegetation pattern in the Gallatin Canyon should be analyzed within the full spectrum of the multiple use concept of management as developed by the Forest Service. The General Forest Zone appears to offer the best potential for development, primarily because it is generally characterized by timber cover with intermittent park and meadow areas. The Crest Zone does not offer the present potential in terms of immediate accessibility, but may well provide future trail and ski run locations. The Water-Influence Zone generally appears to offer the most easily developed sites, but only if extreme care is exercised in planning development.

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*The Fuel Buildup in American Forests: A Plan of Action and Research (1971)

Although the timber resources in Gallatin Canyon are important to the general economy of the region, the principles of multiple use management must remain dominant to any single use if the integrity and the unique character of the Canyon are to be maintained. Only this form of management will continue to afford activity in outdoor recreation, range utilization, timber production, and watershed and wildlife management.

Extreme care must be exercised in developing the various uses under the multiple use management concept. This will require a separate analysis for each individual management unit for its most advantageous use or uses, and must consider the long term impacts on land use options. Sensitive cutting prescriptions are necessary to control harvesting techniques and cleanup procedures where other uses prevail and esthetics are important.

Extreme care should be exercised in development within the study area to insure adequate fire protection. The generally remote locations in Gallatin Canyon are by their very nature extremely hazardous with respect to wildfire. The seasonal thunderstorms and accompanying lightning strikes offer extremely hazardous conditions. Fire occurrences are most frequent during these preiods. If care is taken in selecting development sites, and providing for adequate fire protection, risks to improvements from wildfires could be reduced.

SOILS

Understanding the soils of a given area is vital to determing the many limitations to land use, productivity, and development capacity in the area. Their nature is extremely complex due to the elements that are involved in their formation. The layer of earth we refer to as soil is a dynamic layer of chemical, physical, and biological activities. Its creation is the result of the interaction of the following elements: the regolith or underlying bedrock; climatic influences; large and small organisms, both plant and animal; and the surface relief and drainage of the individual site.

The Gallatin River flows through an exceedingly complex area of geologic structure. The age of the rocks found in the area ranges from very old to rocks formed in recent geologic time. Deposition and uncovering of new rock continues at the present with landslides and mudflows extant in the upper portions of the drainage basin. (The underlying bedrock of the Canyon area is discussed in more detail in the Geology section of this report.)

The northern portion of the study area, bounded by approximately the West Fork on the south, is an area of pre-Cambrian metamorphic rocks. These rocks are extremely hard. Where the soil forming processes have not been exposed to the rock for a very long time, as in the steeper mountain areas, one can expect thin soils with hard rock outcrops. In various locations in higher areas above the river, lava may constitute the bedrock strata. South of the West Fork, sedimentary rocks of the Paleozoic and Mesozoic age are predominant, interspersed with isolated amounts of lava in the higher elevations.

The climate in the region is directly responsible for the relatively rapid formation of soil from the bedrock due to its wide seasonal and diurnal extremes and adequate precipitation. Temperature extremes, as well as the action of precipitation in the form of both snow and rain, tend to break down the bedrock physically and chemically.

The physical elements of the individual site also influence the soil type formed there. This is because differences in surface slope may greatly affect the moisture and air conditions within the soil and its rate of surface erosion. In general, rolling and well-drained uplands provide the best sites for ideal soil development. Soils developed under such conditions are deep and mature. Those developing on steep slopes are likely to be thin and never reach maturity because they are more subject to erosion. Soil types generally reflect these conditions in the Gallatin Canyon area.

Soil Associations

As a part of the Montana State University/Gallatin Canyon Study, Professor G. Nielsen has compiled a description of soils in the Canyon area.* While his studies are incomplete, they have been used here as the only specific reference relative to this subject. Professor Nielsen has gratiously extended the use of this information, but reserving the right to further clarification of the data and interpretations.

Soil types are customarily grouped into associations because a soil type is extremely local, sometimes limited to less than an acre of area. Soil associations are groups of two or more soil types which have similar properties. The following is a discussion of these associations as presented in the MSU (preliminary) report.

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*Nielsen (1971)

Several factors are discussed within each association. Included are the general location of the association, its formative derivation, its characteristics, and the hazards that it may present for land use. Figure I-9 is a map of soil association distribution in Gallatin Canyon, compiled by the Montana State University Center for Environmental Studies.

Bigel-Hobacker Association 1--Well drained gravelly and cobbly soils and shallow gravelly soils. This association contains a number of related soil types. It is dominated by moderately deep and deep, very dark brown to black, well drained gravelly and cobbly soils on sloping fans and nearly level terraces and by shallow gravelly soils on low flood plains subject to flooding. This soil association is found along Highway 191. "It is almost continuous from the mouth of the Gallatin Canyon to the Yellowstone Park boundary. It is on the stream terraces and fans of the Gallatin River and its main tributaries. The soils have formed from alluvium. The terraces have smooth to irregular surfaces and are on one to five percent slopes. Fan slopes are from 5 to 35 percent."* The vegetation consists of bunch grasses, shrubs, and forbs; and the elevation is between 5,200 and 6,700 feet. Mean annual precipitation is between 20 and 30 inches, 11 to 20 inches of this coming in the form of snow. "Frost usually occurs at least once during the summer months."* Approximately 8,800 acres, 7.5

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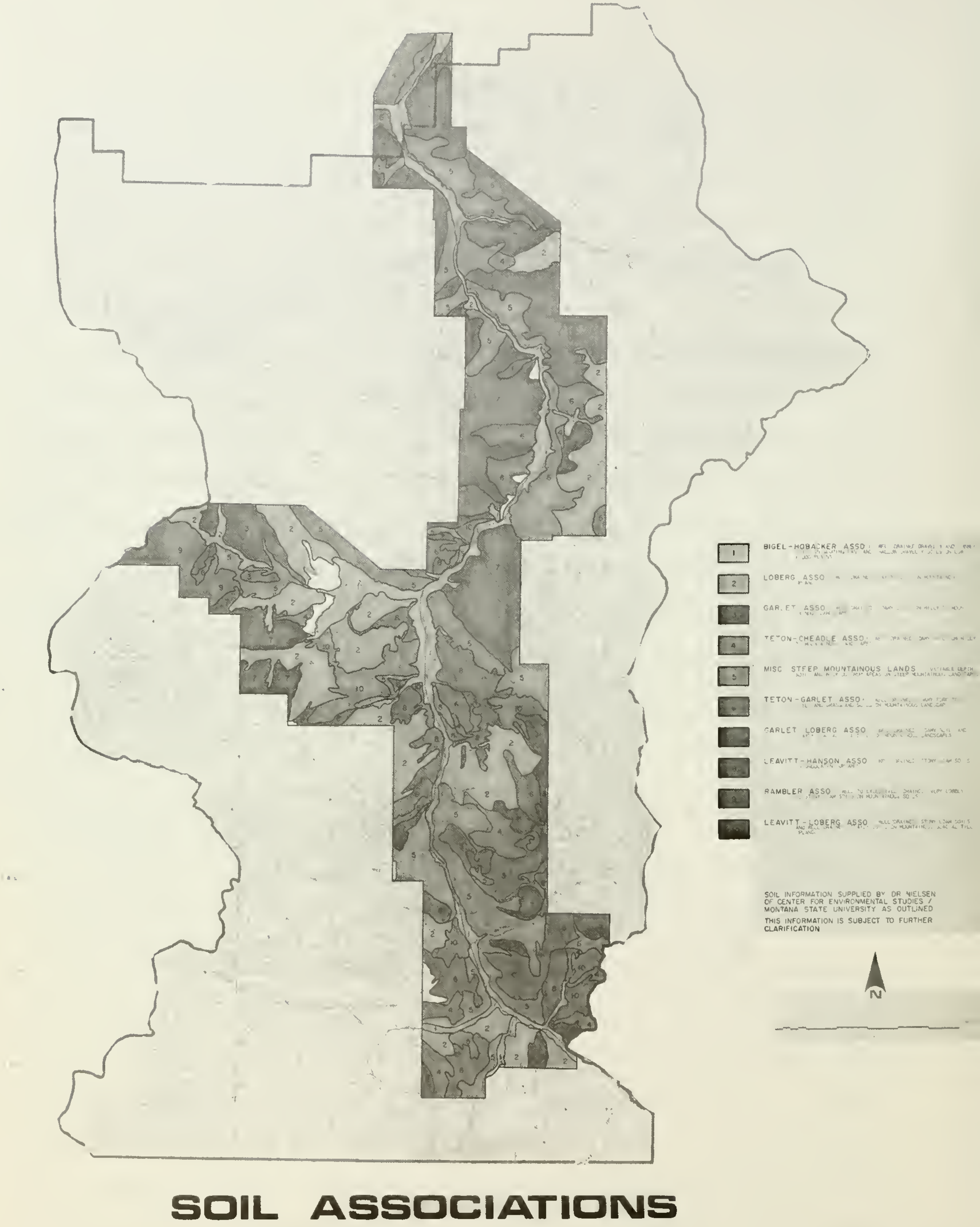
*Nielsen (1971)



SOIL INFORMATION SUPPLIED BY DR NIELSEN OF CENTER FOR ENVIRONMENTAL STUDIES / MONTANA STATE UNIVERSITY AS OUTLINED

THIS INFORMATION IS SUBJECT TO FURTHER CLARIFICATION

SOIL ASSOCIATIONS

GALLATIN CANYON PLANNING STUDY

Figure I-9

percent of the survey area is comprised of the Bigel-Hobacker association.

"Gravelly alluvial soils are on the first and second terraces above the streams and those on the first terraces are subject to annual flooding. Bigel and Bearmouth soils are closely associated on the second and third terraces. Bearmouth soils occur as narrow, low, very gravelly ridges among the Bigel soils. Landscapes are smoother and less channeled than the gravelly alluvial soil terraces. Hobacker and Adel soils are on short fans of 5 to 35 percent slopes between the uplands and the stream terraces. Michaelson soils are on the highest valley terraces, bordering the uplands."* Since this association is along the river and the highway, it is used intensively for picnicking, camping, as a fishing access and as base headquarter for horseback riding, hiking, hunting, snowmobiling, and other recreational uses. The majority of residential development in the Gallatin Canyon area, dude ranches and business establishments, are built on this association. "Management problems are primarily related to the disposal of sewage and garbage which may pollute surface and groundwater resources. Spring flooding of the Gallatin River also presents some hazard and debris problems."*

Loberg-Berglo Association 2--Well drained, clayey soils. This association, consisting of the soil types from which it derives its name and a low percentage of Garlet soils, is dominated by deep, light gray, well drained clayey soils on hilly to mountainous glacial till uplands. The Loberg-Berglo association is on forested glacial till uplands which are undulating to hilly and mountainous. Slopes range from 8 to 40 percent. The association occurs in large areas of the basins of West Fork, Beaver, Porcupine, Portal, Squaw and Moose Creeks as well as other major tributaries of the Gallatin River. "It is commonly located midway between the steep bedrock uplands and the grassland till soils of lower elevations of the valley floor. Much of this association has the typical 'kettle and kame' topography characteristics of till deposits. However, there are some long, smooth, steep slopes,primarily on the upper portions of the association. Rock outcrop occurs in some delineations as narrow ridges or points of knobs. Some very stony areas occur intermittently, but are usually associated with the steeper slopes. Vegetation consists mostly of lodgepole pine and Douglas fir with an understory of pine grass, elk sedge, and shrubs. This association is between the 6,000 and 8,000 feet elevation. Mean annual precipitation is 25 to 50 inches, 15 to 40 inches of this coming in the form of snow. It is common to have a frost during each of the summer months. This association consists of about 20,000 acres, or approximately 17 percent of the survey area. Loberg and Berglo soils occur in an undifferentiated pattern and either soil may occupy from 20 to 60 percent of a delineated area. Combined, they comprise about 80 percent of the association. Soils resting on bedrock at depths less than 20 inches, rock outcrop, rock rubble and other miscellaneous soils make up about 20 percent. Logging operations on this association are severely hampered on slopes over 30 percent. Very stony and rock outcrop areas also present some difficulties in the placement and building of logging roads. Soil losses can be held to a minimum by determining the proper location and gradient of these roads."*

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*Nielsen (1971)

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*Nielsen (1971)

Garlet Association 3--Well drained, loamy soils. The Garlet Association is dominated by light gray, well drained, loamy soils, 20 to 60 inches deep over bedrock on hilly to mountainous landscapes. This forested association of soils occurs on steep mountainous slopes. "The landscape consists primarily of a series of ridges and V-shaped canyons. Slopes range from 8 to 60 percent but are primarily between 15 and 50 percent. The soils are developed in residuum of beltrock, in place, or in these same materials that have moved down slope by gravitational creep. There is a large delineation of these soils between the north and middle fork of the West Fork drainage and in many other major tributaries of the Gallatin River. The vegetation cover is primarily lodgepole pine and Douglas fir with an understory of pine grass, elk sedge, and shrubs. This association occurs at elevations between 7,200 and 8,100 feet. Precipitation is from 30 to 60 inches annually, 20 to 50 inches of this coming in the form of snow. The association comprises about 4,800 acres, or approximately 4.1 percent, of the survey area. It consists of about 65 percent Garlet soils, 20 percent of a soil similar to Garlet that is only 20 to 40 inches deep over bedrock, with forested till soils and other miscellaneous soils making up the balance. Garlet soils are on the long slopes between the ridges and the drainageways. The shallow variant of Garlet is commonly on the upper slopes near the ridges. The ridges, points of hills and down slope knobs are usually occupied by shallow and very shallow soils over bedrock. The surface layer of all these soils is predominantly an angular gravelly loam. However, stony loam areas are not uncommon. In the profiles of all these soils the rock fragment content increases with depth to around 60 to

80 percent, and is highest just above the bedrock. This is a woodland association. Its primary uses are for forest products and watershed. Logging operations are severely hampered on slopes over 30 percent and in rock outcrop or very stony areas. Soil losses can be held to a minimum by determining the proper location and gradient of logging roads."*

Teton-Cheadle Association 4--Well drained, deep loamy soils. Dominated by deep, very dark brown to black well drained loamy soils and by shallow soils over bedrock, this association occurs on hilly mountainous landscapes. "This grassland association of soils is primarily on mountain 'park' areas. The landscapes are generally smooth but may include some ledgerock outcrop areas downslope from the rounded ridges. The dominant slopes are between 10 and 40 percent. This association occurs at elevations between 5,600 and 8,400 feet. Annual precipitation ranges from about 20 inches to nearly 60 inches at the higher elevations, 11 to 40 inches of this falling in the form of snow. Frost usually occurs at least once during each of the summer months at elevations above 6,000 feet. Vegetation consists of Idaho and rough fescues, mountain brome, shrubby cinquefoil, blue grasses, and forbs. This association comprises about 4,800 acres, or approximately 4.1 percent of the survey area. Teton soils make up about 65%, Cheadle 20%, and other miscellaneous soils and rock outcrop about 15%. Cheadle soils are on the convex slopes, and along ridges and rounded knobs. Teton soils are on the long smooth slopes between the ridges and drainageways. Hobacker and Adel soils are most common along creeks. Rock outcrop is usually associated with the Cheadle soils along ridges and points of hills in areas of less than an acre in size. This association is used for the grazing of livestock and wildlife. Elk are the prime users of this association in the Porcupine and Tepee Creek drainages and also in the upper portions of Portal, Beaver, Taylor Fork and other drainages. Proper range management practices and wildlife control measures will maintain and improve the vigor and amount of the more desirable species of grass."*

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*Nielsen (1971)

Miscellaneous Steep Mountainous Lands 5--Rockland, rock outcrop, and rock rubble. This association is dominated by variable depth soils and rock outcrop areas and occurs on very steep mountainous landscapes. "It consists of miscellaneous lands, rockland, rock outcrop, and rock rubble on steep and very steep canyon sidewalls and ridges. The majority of this association is located along the Gallatin River canyon. Miscellaneous lands consist of soils of variable textures and variable depths over bedrock. Content of rock fragments in these soils varies from profiles with only a few pebbles in them to those that are very cobbly and stony. Vegetation consists mostly of lodgepole pine and Douglas fir; however, there are grassland areas and some mixed timber and grass areas. Timber growth is quite variable, ranging from a few scattered trees to some dense groves. The thicker stands are on north facing slopes and along coulees. Logging on this association is made prohibitive by the very steep slopes except on the lower, less sloping fans and footslopes. Grazing is primarily by wildlife. This association comprises about 25,000 acres or approximately 21 percent of the survey area. The shallower soils usually occur on the convex slope along ridges. The deeper soils are on fans and footslopes. About

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*Nielsen (1971)

25 percent of the association consists of rock outcrop and rock rubble. These occur at all levels in the landscape; however, the rock outcrop is dominant on the upper slopes. Limestone and Geltrock Rockland are most common along the Gallatin River canyon; however, Rockland at the head of side drainages and at higher elevations consists of more ancient rocks such as granites and andesites. Much of the soil on the steep slopes has formed in soil material moved down slope by gravitational creep. Soils on the lower slopes are developed mostly in local slope alluvium."*

Teton-Garlet Association 6--Well drained, deep loamy forested soils and grassland soils. "This is a complex association of Teton soils, under grass, and Garlet soils, under timber"* that is dominated by well drained moderately deep to deep, light gray, loamy, forested soils and by deep, very dark brown to black, loamy well drained grassland soils. "They are on hilly to mountainous landscapes where slopes range from 15 to 50 percent. Grassland vegetation consists of Idaho and rough fescues, mountain brome, blue grasses, forbes, and shrubs. Timber consists mostly of lodgepole pine and Douglas fir with an understory of pine grass, elk sedge, wild rose, and other shrubs. Most of this association is between elevations of 6,500 and 8,000 feet. The annual precipitation is between 25 and 40 inches, 15 to 20 inches of this coming in the form of snow. This association comprises about 12,000 acres, approximately 10 percent of the survey area. Teton and Garlet soils are about equal in percent of the association; however, either soil may comprise from 25 to 60 percent of a delineation. Combined they make up about 80 percent of the association. Rambler, Cheadle and glacial till soils similar to Leavitt and Loberg make up about 20 percent. Teton and Cheadle soils are most common on the upper side slopes and convex slope areas respectively. The forested Garlett, Rambler, and Loberg soils occupy the long slopes between the ridges and drainageways. Soil profiles for Teton, Cheadle, and Garlett soils are similar to those described for these soils in Associations No. 3 and 4. This association is used for timber products, watershed, and wildlife. Elk are the prime users of the Teton and Cheadle 'Park' areas."*

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*Nielsen (1971)

Garlet-Loberg Association 7--Well drained, loamy soils and deep clayey glacial till soils. This association is dominated by well drained, light gray, moderately deep, loamy soils and by deep, light colored clayey glacial till soils on hilly to mountainous landscapes. Sharp ridges separated by deep cut canyons characterize the landscape. Rock outcrops, rock rubble, and slump areas are common. "This association is found at elevations of 6,000 to 8,500 feet. Annual precipitation ranges from 25 to 50 inches, 25 to 40 inches of this coming in the form of snow. Vegetation consists of lodgepole pine and Douglas fir with an understory of pine grass, elk sedge, and shrubs. This association comprises about 27,300 acres, or approximately 23.2 percent of the survey area."* The major soil, comprising about 60% of this association is Garlet, which is very gravelly to stony loam. Loberg and Berglo stony soils comprise 20 percent of the association, Teton and Cheadle 10 percent, and other soils 15 percent. "Garlet occurs on the long steep mountain slopes between the ridges and the drainageways unless interrupted by the occurrence of Loberg and Berglo soils on the lower portion of the landscape. These forested till soils also occur at the head of drainageways, immediately below steep mountain cirques. This association is primarily used as watershed; however, some logging is done on some of the less sloping areas. Wildlife also graze the 'park' areas and grass-shrub areas along drainageways."*

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*Nielsen (1971)

Leavitt-Hanson Association 8--Deep, well drained, stony loam soils. Dominated by deep, very dark brown or black, well drained, stony loam soils, this grassland association of soils occurring on undulating to steep glacial till uplands. The landscapes are complex and typically glacial till "kettle and kame" topography. "Most of the slopes are between 8 and 35 percent. This association commonly occurs midway between the forested till soil areas and the soils of the valley terraces below. It occurs at elevations of 5,400 to 6,700 feet. The annual precipitation is 20 to 30 inches, 11 to 20 inches of this coming in the form of snow."* Frost can be expected above 6,000 feet at least once during each of the summer months. "Vegetation consists mostly of Idaho and rough fescues, blue grasses, forbs, big sage and other shrubs. This association comprises about 6,300 acres, or approximately 5.4 percent of the survey area. The largest areas of this association are located on Porcupine, Tepee, West Fork, and Beaver Creek drainages. Leavitt stony loam is the dominant soil type; however, there are areas of cobbly loam and some areas free of coarse fragments in the surface layer. The latter is most common on the north facing slopes of the Porcupine Creek drainage. In this area the Leavitt soils have thicker, dark colored surface layers than is modal for the series. Leavitt soils consistently occupy the sloping lands between the ridges, or knobs, and the drainageways and concave slope areas. Hanson very cobbly and stony soils are on the knobs and ridges. The highest concentration of cobbles and stones is associated with this soil. Adel, Michelson, or Hobacker soils may occur intermittently throughout the association, in small pockets, closely associated with the drainage net. Some seeped soil areas are also along some drainageways. An occasional small intermittent lake is trapped in the undulating uplands. Leavitt soils make up about 60% of the association, Hanson 30%, and other miscellaneous soils 10%. This association is used almost entirely for grazing. Good range management practices are essential to the maintenance and improvement of the native range of this association."*

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*Nielsen (1971)

Rambler Association 9--Very cobbly to stony loam soils. This association is dominated by deep light gray, well to excessively drained, very cobbly to stony loam soils. It "occupies undulating, steep and very steep mountainous landscapes at elevations of 8,000 to 9,000 feet in the vicinity of Lone Mountain and Adesite point. Slopes range from 15% to 60% on the upper slopes, just below the rock rubble of Lone Mountain and Adesite point. Annual precipitation ranges from 40 to 60 inches of which 30 to 50 inches comes in the form of snow. Vegetation is primarily lodgepole pine with an understory of pine grass and shrubs. This association comprises about 2,600 acres, or approximately 2.2 percent of the survey area. Rambler very cobbly loam and Rambler stony loam types comprise about 80% of the association. The very cobbly Rambler soils are on the steepest slopes around Lone Mountain and Andesite point. The stony Rambler soils are on the undulating and less sloping lower portions of the association. This association is used primarily as a watershed. Logging has been limited to the lower slopes."*

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*Nielsen (1971)

Leavitt-Loberg Association 10--Deep, well drained, stony loam soils and deep, well drained, clayey soils. Dominated by deep very dark brown or black, well drained, stony loam soils and by deep light gray, well drained, clayey soils,this soil association is a complex of grassland and forested glacial till soils on undulating to hilly and mountainous uplands. The four main areas of the Leavitt-Loberg association are between Beaver and the West Fork Creeks, along Porcupine and Teepee Creek drainages and also south of the mouth of Cinnamon Creek. "It occurs at elevations ranging between 6,000 and 6,500 feet and slopes range from 8 to 40%. Much of this association has the typical 'kettle and kame' topography characteristic of glacial till soils. Vegetation on the Leavitt soils consists of Idaho fescue, rough fescue, mountain brome, shrubby cinquefoil, bluegrass, and forbs. Lodgepole pine and Douglas fir are the primary vegetation species on the Loberg soils. Annual precipitation ranges from about 20 to 40 inches, of which 11 to 25 inches comes in the form of snow. It is common to have a frost during each of the summer months. There are approximately 5,600 acres in this association comprising about 4.8 percent of the survey area."*

Table I-O, Gallatin Canyon Soil Association Acreages, lists the number and percentages of the soil associations in the Gallatin Canyon study area.

Soil Implications for Development

A study of estimated soil limitations and/or suitability for

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*Nielsen (1971)

TABLE I-0*

SOIL ASSOCIATION ACREAGES
Gallatin Canyon

Soil Association Number	Calculated Acres	Calculated %	Rounded Acres	Rounded %
1	8,754	7.45	8,800	7.5
2	19,918	16.95	19,900	16.9
3	4,832	4.11	4,800	4.1
4	4,842	4.12	4,800	4.1
5	24,960	21.24	25,000	21.2
6	12,102	10.30	12,100	10.3
7	27,291	23.22	27,300	23.2
8	6,300	5.36	6,300	5.4
9	2,600	2.22	2,600	2.2
10	5,609	4.77	5,600	4.8
Recent Slide Area	309	0.26	300	0.3
Total	117,523	100.00	117,500	100.00

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*Nielsen, G.A. (1971)

selected land uses has been developed for the Canyon area by Dr. Gerald Nielsen of the MSU Study Team. Dr. Nielsen and members of his team delineated fifteen different utilizations of the soils in the Canyon. Different types of human usage such as picnic areas, campsites, septic tank filter fields, roads, trails, and building sites were identified. The soil types were then rated as having slight, moderate, or severe limitations for the different uses. Table I-P presents the results of their findings.

Review of this information indicates that five of the soil associations offer less severe restrictions or limitations than do the others. These are Bigel-Hobacker, Loberg, Teton-Cheadle, Leavitt, and Leavitt-Loberg associations. This analysis provides a guide to land use development and offers a basis for predicting possible consequences of unwise land utilization. Ultimately the homeowners, property owners, contractors, and taxpayers will have to bear the cost of ignoring the natural soil limitations. Many limitations, however, can be overcome by investing in additional planning study.

The following explanation has been supplied by Dr. Nielsen.

Explanation of Soil Interpretations

Table I-P lists the "Soil Associations" by number and shows the soil series in each association. It gives the approximate percent of each soil series and also the percentage of "other soils" included in the association. (All of these soils are described in the Soil Associations explanation.) Soil limitations or suitability ratings as given in Table I-Q are for evaluating the soils for a particular use. Only the most significant limitations or hazards are given.

TABLE I-P ESTIMATED SOIL LIMITATIONS OR SUITABILITY FOR SELECTED USES**

				SOIL LIMITATION FOR:													SUITABILITY AS A SOURCE OF:		
				FOUNDATION FOR LOW BUILDINGS					RECREATION					POND SITES					
Soil Ass'n.	Soil* Series	% Slope	Percent of the Association	With Basement	Without Basement	Septic Tank Filter Fields	Roads and Parking	Lawns and Landscaping	Camping Areas	Picnic Areas	Playgrounds	Trails and Paths	Sanitory Land Fills	Reservoir Area	Embankment Material	Logging	Topsoil	Fill Material (other than embankment)	Sand and Gravel
1 Bigel Hebacker	Bigel	0-5	25	M 2	S	M 7	S	S	M 5, 15	M 12	M 5, 15	M 12, 15	M 2	M-V 14	F 15	Non-forested	F 4, 15	G	G-F 2
	Hobacker	5-35	25	S	S	M-V 3	M-V 3	M-V 3	M-V 3	M-V 3	V 3	M 3	M-V 3	V 3	F 15	S	F-G 15	G	Unsuitable
	Bearmouth	0-5	10	M 2	S	M 7, 20	S	M 4, 15	M 15	S	V 15	M 15	M 2	V 6, 14	P 15, 20	Non-forested	P 4, 15	G	G
	Gravelly Alluvial Land	0-5	20	V 2	V 2	V 7, 20	V 1, 2	V 1	V 1, 2, 15	M 1	V 1, 14, 15	M 1	V 1, 2	V 6, 14	P 15	Non-forested	P 4, 15	F 1, 2	F 1, 2
	Michelson	2-10	10	S	S	S M 3	M-V 10, 18	S	S	S	S-M 3	S	S	M 6	F 13	Non-forested	G	F 8, 10, 18	Unsuitable
	Kissick	0-3	2	V 11, 12	V 11, 12	V 5	V 12, 18, 22	V 12	V 5, 12, 16	V 12, 16	V 5, 12, 16	V 12, 16	V 5, 12	S	P 11, 12, 22	Non-forested	P 12	P 11, 12, 22	Unsuitable
	Tonks	0-3	2	V 2	V 2	V 2	V 2	V 2, 19	V 1, 2	V 2	V 2, 16	V 2	V 2	S	P 8, 13, 22	Non-forested	P 19	P 2, 8, 10, 19	Unsuitable
	Other		6																
2 Loberg	Loberg	8-40	80	M-V 3, 11, 12	M V 3, 11, 12	V 3	M-V 3, 10	M-V 3	M-V 3, 15	M-V 3, 15	V 3, 15	M 3, 15, 21	M-V 3	V 3	G	S-M 3	P 4, 15	G	Unsuitable
	Garlet	15-50	10	V 3, 17	V 3	V 3, 17	V 3	V 3	V 3	V 3	V 3, 15	M-V 3, 15, 21	V 3	V 3	F-P 15	S-M 3	P 4, 15	G	Unsuitable
	Other		10																
3 Garlet	Garlet	15-50	60	V 3, 17	V 3	V 3, 17	V 3	V 3	V 3	V 3	V 3, 15	M-V 3, 15, 21	V 3	V 3	F-P 15	S-M 3	P 4, 15	G	Unsuitable
	Garlet Shallow Variant	8-35	20	V 3, 17	M-V 3	V 3, 17	M-V 3, 17	V 3, 15, 17	V 3	V 3	V 3, 15	M V 3, 15, 21	V 3, 17	V 3, 17	P 15	S-M 3	P 4, 15	G	Unsuitable
	Loberg	8-40	10	M-V 3, 11, 12	M-V 3, 11, 12	V 3	M-V 3, 10	M-V 3	M-V 3, 15	M-V 3, 15	V 3, 15	M-V 3, 15, 21	M-V 3	V 3	G	S-M 3	P 4, 15	G	Unsuitable
	Other		10																
4 Teton Cheadle	Teton	10-40	65	M-V 3, 17	M-V 3	V 3, 17	M-V 3, 10	M-V 3	M-V 3	M-V 3	V 3	M 3	M-V 3	V 3	F 8, 13	Non-forested	G	F 9, 10, 18, 22	Unsuitable
	Cheadle	10-40	20	V 17	M-V 3	V 3, 17	M-V 3, 17	V 3, 17	M-V 3, 15	M-V 3, 15	V 3, 15	M 3	V 3, 17	V 3, 17	F 15, 17	Non-forested	F 4, 15	G	Unsuitable
	Other		15																
5 Misc. Lands	Steep Misc. Mountain Lands	35-100		V 3	V 3	V 3	V 3	V 3	V 3	V 3	V 3	V 3	V 3	V 3	P 15	V 3	P 4, 15	Too variable to evaluate	Unsuitable
6 Teton Garlet	Teton	10-40	40	M-V 3, 17	M-V 3	V 3, 17	M-V 3, 10	M-V 3	M-V 3	M-V 3	V 3	M 3	M-V 3	V 3	F 8, 13	Non-forested	G	F 9, 10, 18, 22	Unsuitable
	Garlet	15-50	40	V 3, 17	V 3	V 3, 17	V 3	V 3	V 3	V 3	V 3, 15	M V 3, 15, 21	V 3	V 3	F-P 15	S-M 3	P 4, 15	G	Unsuitable
	Other		20																
7 Garlet Loberg	Garlet	15-50	65	V 3, 17	V 3	V 3, 17	V 3	V 3	V 3	V 3	V 3, 15	M-V 3, 15, 21	V 3	V 3	F-P 15	S-M 3	P 4, 15	G	Unsuitable
	Loberg	8-40	20	M-V 3, 11, 12	M-V 3, 11, 12	V 3	M-V 3, 10	M-V 3	M-V 3, 15	M-V 3, 15	V 3, 15	M 3, 15, 21	V 3	V 3	G	S-M 3	P 4, 15	G	Unsuitable
	Other		15																
8 Leavitt	Leavitt	8-35	60	M-V 3	M V 3	M-V 3	M-V 3, 10	M-V 3	M-V 3, 15	M-V 3, 15	V 3, 15	M 3	M-V 3	M-V 3	G	Non-forested	F 15	F-G 10, 22	P
	Hanson	8-35	30	M-V 3, 15	M V 3, 15	M-V 3	M-V 3, 10	M-V 3, 15	M-V 3, 15	M-V 3, 15	V 3, 15	M 3, 15	M-V 3	V 3	F-P 15	Non-forested	F-P 15	G	P-F 15
	Other		10																
9 Rambler	Rambler	15-60	80	V 3	V 3	V 3	V 3	V 3, 15	V 3, 15	V 3, 15	V 3, 15	V 3, 15, 21	V 3	V 3	P 15	M-V 3	P 4, 15	G	Unsuitable
	Other		20																
10 Leavitt Loberg	Leavitt	8-35	40	M-V 3	M-V 3	M-V 3	M-V 3, 10	M-V 3	M-V 3, 15	M-V 3, 15	V 3, 15	M 3	M-V 3	M V 3	G	Non forested	F 15	F-G 10, 22	P
	Loberg	8-40	40	M-V 3, 11, 12	M-V 3, 11, 12	V 3	M-V 3, 10	M-V 3	M-V 3, 15	M-V 3, 15	V 3, 15	M 3, 15, 21	V 3	V 3	G	S M 3	P 4, 15	G	Unsuitable
	Garlet	15-50	10	V 3, 17	V 3	V 3, 17	V 3	V 3	V 3	V 3	V 3, 15	M-V 3, 15, 21	V 3	V 3	F-P 15	S-M 3	P 4, 15	G	Unsuitable
	Other		10																

*Soil series names are tentative.

Legend - S Slight
M Moderate
V Severe
G Good
F Fair
P Poor

These interpretations may be used to guide the development of general plans. They do not eliminate the need for on-site soil investigations for design and construction.

By J. A. Olsen, B. F. Leeson and G. A. Nielson**

LIMITING SOIL PROPERTIES AND HAZARDS INDICATED BY NUMBER IN TABLE I-Q

1. Flooding or ponding hazard (overflow)
2. Seasonally high ground water
3. Excessive slope
4. Thin surface layer (topsoil)
5. Slow permeability
6. Rapid permeability
7. Ground water contamination hazard
8. Erosion hazard
9. Unfavorable organic matter content
10. Susceptibility to frost heave
11. High skrink-swell
12. Unfavorable clay content
13. Piping hazard
14. Shallow depth to sand and gravel
15. Gravel, cobble, and stone
16. Slippery or sticky when wet
17. Shallow depth to bedrock
18. Low bearing strength
19. Salinity
20. Sandy texture
21. Tree downfall
22. Unfavorable compaction characteristics

Interpretations are based on evaluation of the soil to a depth of five feet. However, some interpretations can be made below this depth. Geologic reports may be of benefit for interpretations below the five foot depth. For a proposed construction, a detailed investigation at "the site" is needed. The soil interpretations are for soils in the natural state and not for disturbed areas.

Soils rated as slight are relatively free of limitations or have limitations that are easily overcome. Soils rated as moderate have limitations that need to be recognized but can be overcome with good management and careful design. A severe rating indicates the limitations are severe enough to make use questionable. It does not mean the soil cannot be used for a specific use, but it does mean that careful planning and design, and very good management are needed. In some cases, the limitations may not be economically feasible to correct.

The significance of soil properties affecting the use of the soils in Table I-P differs, depending on the particular use.

Interpretations are not included for wildlife use. However, it is recognized that all soils are suited for some form of wildlife and that this is an important use which is compatible with other uses.

Definition of Selected Uses

Foundations for Low Buildings. Interpretations indicate limitations for construction and maintenance of homes and small buildings less than three stories high. They are affected by soil characteristics such as frost heave potential, shrink-swell, slope, depth to bedrock, stoniness, texture, salinity, compaction, and flood hazard. (Limitations for on-site sewage disposal is rated separately.)

Septic Tank Filter Fields. Successful operation of the system depends on the ability of the soil to absorb and filter the liquid or effluent passed through the tile field. Filter fields are influenced by the ease of downward movement of effluent through the soil. Soils with slow permeability are rated severe. Other soil properties that effect septic tank filter fields are flooding hazard, depth to bedrock, seasonal high ground water, and slope. Clean sands and gravels with rapid permeability may constitute a hazard for ground water contamination.

Road and Parking Location. Based on those features that affect performance for the location of highways, streets, and parking areas. The main factors considered are depth to water table, flooding hazard, depth to bedrock, susceptibility to frost heave, shrink-swell potential, compaction characteristics, bearing strength, and slope.

Lawns and Landscaping. The soil is rated on the assumption it will be used for lawn turf, shrubs, and trees without the need for adding topsoil for good establishment and also that irrigation is provided. Soil characteristics affecting this use are depth to seasonal very high ground water, depth to bedrock or gravel, stoniness, surface soil texture, salinity, and slope.

Camp Areas. Considered to be used intensively for tents, truck campers, and small camp trailers with the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and leveling for tent and parking areas. The soils should be suitable for heavy foot traffic by humans and for limited vehicular traffic. Permeability, texture, slope, depth to water table, flooding hazard, and stoniness affect suitability for this use. Soil suitability for growing and maintaining vegetation is not rated but is an item to consider in final evaluation of the site.

Picnic Areas. Considered to be extensively used as park-type picnic grounds. It is assumed that most vehicular traffic will be confined to access roads and parking areas. Permeability, slope, flood hazard, surface soil texture, and surface stoniness affect suitability for this use. Soil suitability for growing vegetation is not rated but is an item to consider in final evaluation of the site.

Playgrounds. For recreation applies to soils that are to be used intensively for organized games such as football, baseball, volleyball, horseshoes, and other similar organized games. They are subject to heavy foot traffic. A level surface, good drainage, and a soil texture and consistence that gives a firm surface but is not slippery and sticky when wet is generally required. Soils that are stony, very shallow, sloping, subject to flooding, or have seasonally high water tables are rated severe.

Trails and Paths. Considerations are in terms of uses for local and cross-country footpaths and trails for bridle paths. It is assumed that these areas will be used as they occur in nature and that little or no soil will be moved (excavated or filled). Soil features that affect trafficability, dust, design, and maintenance of trafficways should be given special emphasis. Soils that are poorly drained, flood frequently, are very stony, have clay surface textures or steep slopes are rated as having severe limitations or hazards.

Sanitary Land Fills. Disposal areas for trash and garbage. A good sanitary land fill should be usable all year and should operate without contaminating water supplies or causing a health hazard. Soil factors considered in rating the limitations for use are seasonal high water table, permeability, slope, stoniness, texture, depth to bedrock, and flood hazard.

Pond Sites. Consist of the Reservoir Area and Embankment Material. The reservoir area is rated on the adequacy of the soil material to prevent seepage from the reservoir. Soil properties most important are permeability, slope, depth to sand and gravel, depth to bedrock, and seepage rate. Depth to water table influences the depth of the water in dugouts, pits, etc. in all kinds of soil materials so is not rated for this use. The soil properties considered for embankment material are those features of disturbed soils that affect their suitability for constructing earth fills. These include compaction characteristics, compacted permeability, differential settling, shrink-swell, resistance to piping, salinity, high content of stones and erosiveness.

Suitability as a Source of Topsoil. Topsoil is considered to be used for establishing lawns. A rating of "good" means the soil provides a good source of topsoil for removal and transfer to another place or it can be used in place. Soils are rated on the thickness of the surface layer, texture, accessibility, salinity, stoniness, and wetness of the surface layer of undisturbed soils.

Suitability as a Source of Fill Material. Rated on the basis that the material is removed and transported to another area to be used as fill material for buildings, roads, etc. Texture of the subsoil and substratum, susceptiblity to frost heave, plasticity, erosion hazard, shrink-swell potential, and compaction characteristics are factors affecting the use of a soil as fill material. Soils that have a high water table or flooding or ponding hazard that keeps water in the borrow area are rated fair.

Sand and Gravel. Only the suitability as a SOURCE for sand and gravel is rated in Table I-P. No attempt is made here to rate the QUALITY of the sand and gravel for specific uses such as road base, concrete, etc. Quality determinations should be made at the site of the source since both grain sizes and shapes of sand and gravel determines suitability for specific uses.

Logging. Some of the major limitations related to this use are extremely stony areas, rock outcrops, slump or slide areas, clay surface textures and steep slopes. Slope is the only limitation rated in Table I-N since most of the other limitations occur in small areas among most of the timbered soils. Slopes of 0 to 30 percent are generally considered as comprising a slight limitation, 30 to 60 percent is moderate, and 60 percent or steeper is severe.

FISH AND WILDLIFE

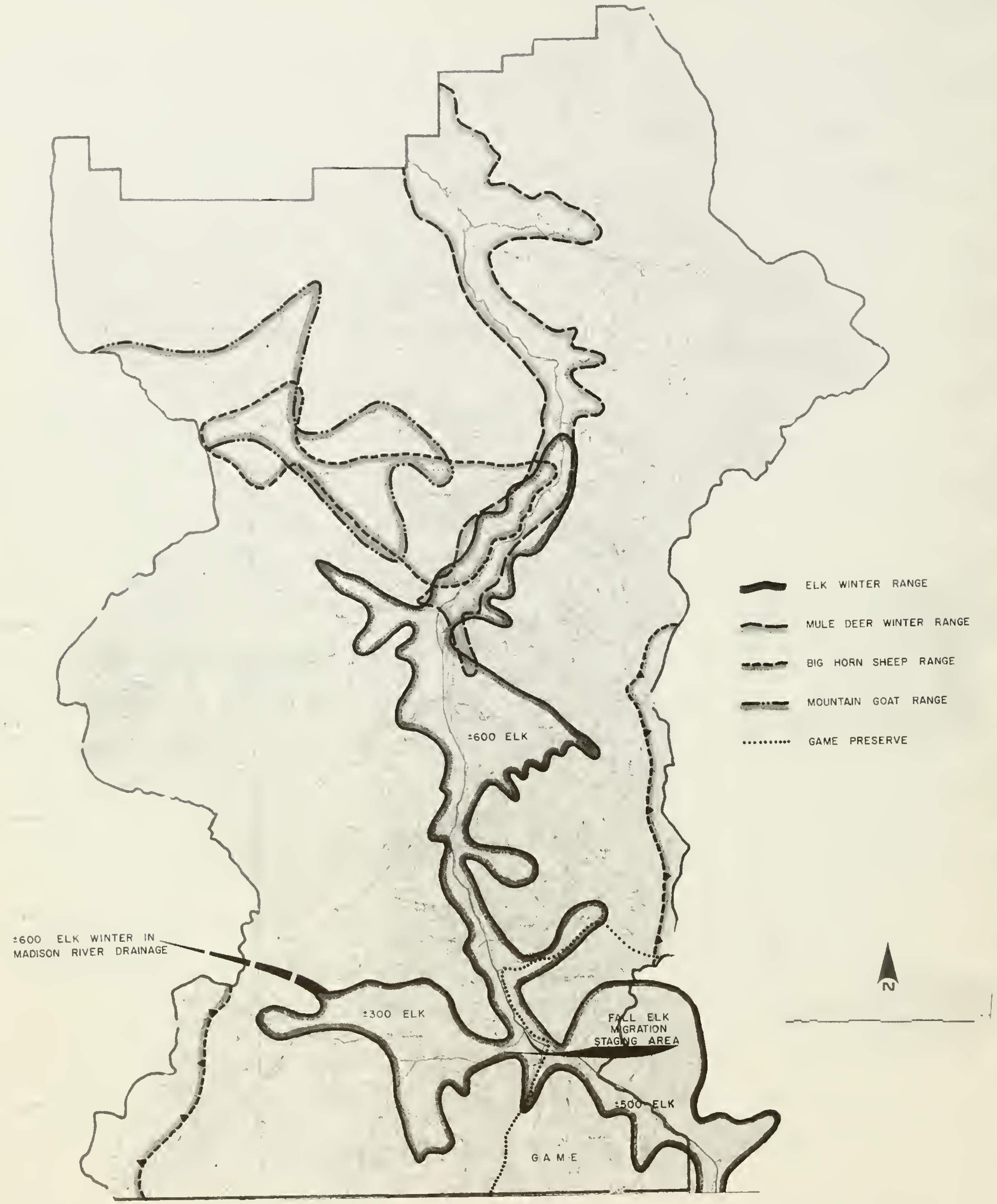
The wildlife in an area, if studied by a knowledgeable observer, provide observable indicators of the condition of the season's vegetation and climatic elements. The numbers of animals as well as their condition relate directly to the availability of winter food, except for those species which hibernate over the winter.

The density and distribution of animal populations depend on the suitability of the habitat--the combination of vegetation, soil, and other environmental factors which enable wildlife species to live in a certain locality. Natural changes, such as fire or disease, in the density of any one specie of browsing, grazing, seed-eating or predatory mammals may affect the balance in the natural community. These changes do not usually precipitate a dramatic chain reaction of community responses. Stable communities become disturbed as a consequence of some human disturbance such as the introduction of alien species of plants or animals, farming, grazing, logging, or use of fire.

Man's continuing involvement in Gallatin Canyon undoubtedly will have a tremendous impact upon the total ecosystem. For purposes of this report, only those species that are game species that could be adversely affected by continuing development will be discussed. Data for this section have been obtained from various state and federal fish and game publications.

Wildlife

The following table (Table I-R, Forest Service Wildlife Census, 1959-1970) presents a synopsis of the wildlife population



WILDLIFE RANGES

GALLATIN CANYON PLANNING STUDY

Figure I-10

TABLE I-R

FOREST SERVICE WILDLIFE CENSUS,1959-1970
(Area not Restricted to Gallatin Canyon Study Area)

Species	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Ave.	Harvest 1970
Deer, Mule	1000	1000	1000	1000	1000	1000	1000	1000	2000	2000	2000	2000	1450	350
Elk	2500	2500	2500	2500	1400	1540	2100	1495	1915	1370	2000	2500	2026	425
Moose	250	300	300	300	300	400	400	450	475	475	475	475	383	50
Mountain Goat	50	50	50	60	60	60	60	60	60	60	60	70	58	10
Sheep, Bighorn	250	250	250	250	250	175	170	155	155	155	150	150	197	4
Bear, Black	100	100	100	100	100	100	100	100	150	200	150	125	119	20
Bear, Grizzly	10	10	10	10	10	10	10	10	10	15	10	10	10	0

This table is included herein as the best available census information and represents little more than an estimate determined by the U.S. Forest Service. No scientifically sound census methods were used to determine these numbers. Figures for the elk are probably the most sound due to work being done by the Forest Service in cooperation with the Montana State Fish and Game Department on the Gallatin Elk Herd.*

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*Robert Cron, District Ranger, Gallatin National Forest.

in the Gallatin Canyon region. This table contains information relative only to those species that inhabit the area; namely, mule deer, elk, moose, mountain goat, bighorn sheep, and black bear. The species with the most representation in the canyon region is the elk, for which Gallatin Canyon is famous.

Elk

The Gallatin elk herd is divided into two management units by the U. S. Forest Service. The Gallatin elk is a descendant of the elk group of the genus Cervus which originated in Asia and probably reached American during the Ice Age by crossing the land bridge at the Bering Strait. The U. S. Forest Service Wildlife Census, 1959-1970, shows the elk herd size to vary between 1500 to 2500 head with a current population of approximately 2000.

Upper Gallatin Herd. This herd is migratory, spending the summers in Yellowstone Park and the winters along the periphery of the Park and further north in the Gallatin drainage. A portion of this herd migrates to the Beaverhead National Forest on the west slopes of the Madison Range. (Fig. I-10, Seasonal Migration Patterns, Gallatin Canyon Elk.) The history of the Upper Gallatin elk herd is described very well in Part I of the U.S.F.S. 1965 Tri-Agency Elk Management Plan and will not be duplicated here.

"Management of the habitat is hampered by land ownership patterns. A considerable amount of the key winter range is located on other than National Forest lands. There is no permitted domestic livestock grazing on elk winter range in the Upper Gallatin, except on the upper elevation areas of the winter range in Sage, Wapiti and Cache Creeks."*

The key critical winter ranges are open, south and west facing slopes in lower Porcupine Creek, the area east of Meadow Lake in Taylor Fork, and slopes of Crown and Jara Buttes.*

The winter range for the elk is not heavily timbered, but rocky with little forage. The key range is open grasslands and sagebrush- grasslands interspersed with timber. The condition of the key range is poor, but with an improving trend. Large areas become covered by deep snow, and during severe winters, the elk must find forage on sloping ground with a general south or west exposure where the snow melts off or blows away. These exposures are drier and have poorer soil development than the sites protected by snow. They are grazed by elk every winter. Additional important forage sources during winter include willows and other browse plants, since they are available above the snow. Elk eat conifer needles, limbs, and bark when they are starving.

Lower Gallatin Herd. This herd is broken into many small units of animals occupying the lower half of the Gallatin drainage, including the Spanish Peaks Wilderness Area, and the north face of the Gallatin range. Little is known concerning this herd, compared to the Upper Gallatin herd. The population was estimated to be 350 head in 1964.* (This figure is thought to be inaccurate by the State Department of Fish and Game.)

Condition of the winter range for this herd is not well established. The winter range on the west side of Gallatin below West

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*Wildlife Management Plan (1964)

Fork is shared with deer and bighorn sheep. There is no permitted domestic livestock in this area. Winter use in the area is apparently very heavy. The herd summers in the head of most of the area's drainages.

Elk Herd Size. The Gallatin elk herd has been subjected to great human disturbances such as heavy livestock grazing affecting the vegetation and soil; cutting the meadow for hay; constructing roads, trails, and buildings; logging; and the suppression of fires which reduced the regeneration of browse plants such as aspen and willows.

The most knowledgeable about the interrelationship between the size of the elk herd and the condition of its range advocate the maintenance of a stable herd size, with a harvest taken annually to achieve this end. Their reasoning is that the elk will die from starvation if the herd is too large to maintain itself on existing forage, particularly during a severe winter. In addition, a large herd can do untold damage to its range. Montana Fish and Game authorities have resolved that a herd size of 1000 head is the maximum carrying capacity of the range. The guest ranches, that secure many of their customers as hunters in the fall season, would like to have as many elk as possible spill over into the canyon from the Park.

Controversy has raged for years about the care of elk and deer, particularly elk. One faction has felt that the elk should be fed during severe winters, a practice which has been found to be detrimental to a herd because it destroys the animal's foraging instincts. Farming interests in the canyon are opposed to having elk attack their hay stacks and mingle with their stock, and urge feeding programs in the winter. Neither the State nor Forest Service allow feeding on their lands, and in fact are opposed to feeding for several reasons.

Artificial feeding of the animals can result in an interruption or interference with natural migrations and unusual concentrations on unnatural winter sites. These concentrations often cause severe damage to their emergency food supply and tend to result in increased coliform counts from spring runoff when feeding is adjacent to the Gallatin River. These concentrations also aid the spread of disease by gathering great numbers of animals.

If a feeding program is needed, it should be a coordinated effort among those agencies with that specific responsibility--notably the State Fish and Game Department and the Forest Service. Both agencies agree feeding should be done only in extreme conditions, and this will not happen if the herd population is controlled.

Mule Deer

Mule deer are found sparsely distributed throughout the entire area. Their winter range is restricted to along the valley floor to the east of the Spanish Peaks Wilderness Area in the lower Gallatin Canyon.

No formal estimate of the number of mule deer have been made Available wildlife publications show figures indicating the population has doubled in the past seven years, from 1000 to 2000 head. Referring back to Table I-R, the mule deer population is shown to increase from 1000 to 2000 between 1966 and 1967. Even under very optimistic productivity rates and a complete cessation of harvest and other mortality factors, this feat would be very difficult to accomplish. One problem in the harvesting of the mule deer has been securing rights-of-way to provide public access to federal lands. There are no formal Fish and Game or Forest Service estimates of harvest. Several animals are killed yearly by vehicles on U.S. 191.

Their forage consists of browse in creek bottoms and forbs on the steep open slopes. Overused browse occurs in some areas. "In the Deer-Dudley-Asbestos Creek areas, bighorn sheep and deer compete for available forage. Generally from Squaw Creek south on the east side of the Gallatin River, moose are also competing for available browse."* The mule deer requires good natural cover and sufficient browse as the two key environmental controls to his existence.

Bear

Two species of bear inhabit the Gallatin Canyon area, the black bear and the grizzly bear. The black bear is relatively numerous, with 125 individuals estimated in 1970. Hunting of both species is permitted; however, there were no grizzlies taken during the period from 1959-1970. Bears are wary and crafty and usually shun the activities of man and civilization.

Both bears are normally found in the higher reaches of the coniferous forest, but they do have a wide range and can be found in the steep canyons of the stream reaches. They are both omnivorous feeders, eating everything from berries to rodents. Grasses and forbs are also major food sources. Man has been the prime enemy to the bear, and his habitat is dictated by man's presence or absence.

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*Wildlife Management Plan (1964)

Bighorn Sheep

Bighorn sheep range along the entire Yellowstone-Gallatin divide from the head of Squaw Creek to the Yellowstone Park boundary. They also range in the Spanish Peaks area and in the east-west divide south of Taylor Fork Creek. They winter on areas from high elevation ridges to low river valleys with their key winter ranges the low, open slopes of Dudley, Asbestos, and Deer Creeks. They compete with the elk and deer for forage.

Moose

Moose are found throughout the district, at almost any elevation, summer and winter. They prefer the willow bottoms of the Gallatin in winter, but may also be found in the upper ends of the drainage. Their population is controlled by an annual harvest with an average of 70 animals from a herd of 300+.

Cougar and Bobcat

Both are common residents of the Gallatin Canyon, but are not often seen.

Waterfowl and Upland Game Species

No specific counts exist on use of the area by waterfowl and upland game species. Mallard ducks may be found year round on the Gallatin River, where springs keep the water open. Blue grouse, ruffled grouse, and Franklin grouse are found throughout the Canyon in moderate numbers.

Fish

This resource receives the most attention of all categories of wildlife in the Gallatin Canyon. The Gallatin River is a designated blue-ribbon trout stream, receiving extremely heavy use in late July and August. There are 140 miles of fishing streams, 38 natural lakes encompassing an estimated 380 acres and two impoundments, Rat Lake and Meadow Lake, covering 112 acres. Rainbow trout are stocked in the main West Gallatin and only a few of the tributaries. Regular stockings of brown trout, cutthroat trout, and brook trout has ceased. The Montana Fish and Game Department has not made intensive surveys of any streams tributary to the Gallatin River in the Canyon.

Grazing Livestock

Livestock grazing has occurred in the region since it was settled. When the region was placed under the jurisdiction of the National Forest authorities, permits were granted for the grazing of cattle, horses, sheep, and goats. Records over the last fourteen years show cattle and horse grazing permits have been on the increase with sheep and goat grazing permits on a steady decline. In 1970, there were 2,375 cattle and horses, and 1,370 sheep and goats permitted under grazing permits.

Entomology

Information compiled by the Montana State University Center for Environmental Studies points out several significant facts about insects in the area.

First, comparing the sample areas with streams in other parts of the country it can be stated that none of the areas show high insect counts, indicating that present conditions are not causing much eutrophication. This means that enrichment in any quantity may affect a significant change on the water quality and insect population.

Second, the survey found that the dipterous fauna of all streams is low. This is significant because Diptera are often the dominant forms in polluted streams. More significant is that pollution tolerant Diptera forms are not present.

Third, those insect forms present are preferred trout food, e.g., Tricoptera and Plecoptera on the West Gallatin and Ephemeroptera on the West Fork. A change from these to dipterous fauna would spell the end to the trout fisheries.

Implications for Development

Wildlife is a primary attraction of Gallatin Canyon. Fishing and big game hunting account for the present major recreation uses of the area. Most notable are the famous Gallatin elk herds and the trout of the blue ribbon Gallatin River.

Increasing winter and summer recreation uses in the Canyon and nearby areas are presenting wildlife management problems. Pressure for other uses of land that has historically been the range of these animals will cause them to either decline in number or move into areas of less intensive habitation. Hunting and fishing activities in Gallatin Canyon will come under even greater pressure as other uses of the area increase.

Gallatin Canyon wildlife are managed jointly by the Montana Department of Fish and Game and the Gallatin National Forest. The checkerboard pattern of jurisdictional coverage in the Canyon has made it almost impossible to manage habitats and herds. Most notable has been the problem of winter forage for the herds, the other recommending the herd forage itself.

The question of winter feeding and herd size are management decisions and should be based on needs of the herd. Careful consideration should be given to coordinating wildlife management practices throughout the Canyon to insure the continuance of these vital occupants.

CULTURAL ENVIRONMENT

Cultural, or man-made activities, mean all changes to the natural environment resulting from human action. The cultural elements of the Gallatin Canyon planning area consist of: existing land uses, transportation, demographic features, land ownerships, utilities and related services, economic character, and governmental aspects.

Early Settlement

Permanent settlement in the Canyon began about 1890. "The early settlers in the Gallatin Canyon were greatly attracted by its beauty and its emotional hold upon them was soon very strong. Cattle ranching had seemed to be a logical operation, but the deep snows of the long winters made the profits marginal. The lure of trapping and prospecting attracted many, but their profits were even less. A number sensed that the Canyon would have an attraction for summer vacationers, and the 'dude ranching' industry came to the Canyon in 1906."* For a complete accounting of early settlement patterns and happenings, the reader is referred to Burlingame.

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*Burlingame, (1970)

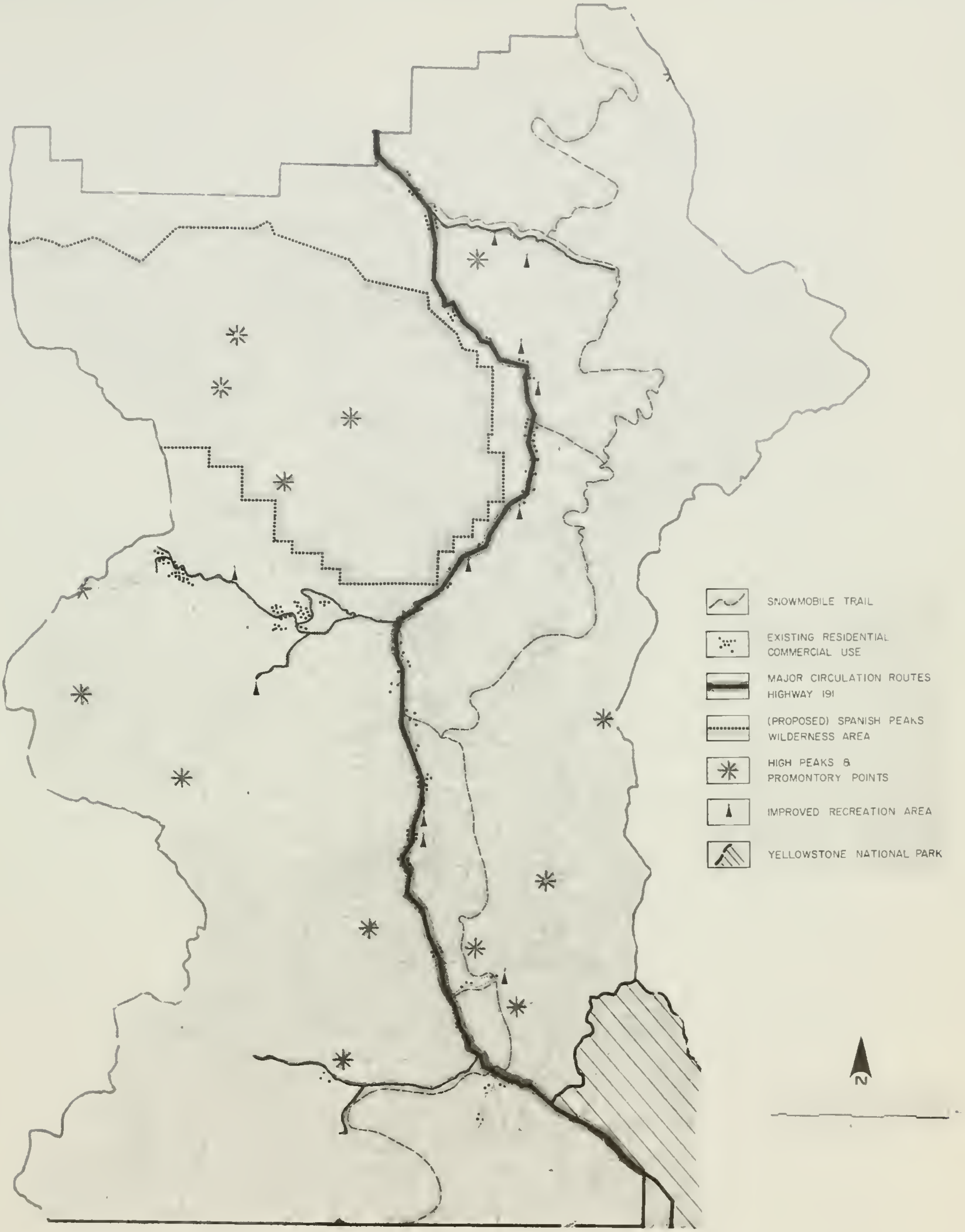
EXISTING LAND USES

The Gallatin Canyon, because of its location and mountainous terrain and its limited population, has a distinct and relatively simple land use pattern. The area is predominantly forested. The Forest Service has jurisdiction over 280,300 ± acres, of the region. This jurisdiction includes fire protection, garbage and waste disposal, the granting of grazing and logging permits, wildlife management, visitor accommodations and control, and range and forest maintenance. A major portion of the study area lies in Gallatin National Forest, including the Spanish Peaks Primitive Area.

The following map indicates the existing land useage in the study area. Specifically, there are four general land uses shown on the map: residential and commercial useage; circulation routes; and those areas offering existing recreational uses.

The strongest defining features of the Canyon are the steep, heavily timbered mountain slopes and the river. The mountains constrain access, while providing ideal opportunities for recreation. The topography creates separate distinct identities for the different areas of the Canyon. Neighborhood enclaves are scattered throughout the area, exhibiting small-scale development, and somewhat of a continuity in architectural character.

Existing land uses are mixed, but they fall within the general catagories of housing and supporting commercial activities, and


SNOWMOBILE TRAIL
EXISTING RESIDENTIAL COMMERCIAL USE
MAJOR CIRCULATION ROUTES HIGHWAY 191
(PROPOSED) SPANISH PEAKS WILDERNESS AREA
HIGH PEAKS & PROMONTORY POINTS
IMPROVED RECREATION AREA
YELLOWSTONE NATIONAL PARK
N

EXISTING LAND USES

GALLATIN CANYON PLANNING STUDY

Figure I-11

forestry. Residential densities are highest in the suburban areas just north of the study area - Gallatin Gateway and Bozeman Hot Springs. It should be noted that in these areas there have recently been several new proposals for housing subdivisions or mobile home parks presented to County officials. Within the Canyon, the forthcoming Big Sky development will provide a relatively compact, year-round residential-recreational community.

Supporting commercial activities are located alongside Highway 191. They range from direct service facilities (food-stores, etc.) to tourist-oriented facilities (bars, restaurants, antique shops, etc.). These commercial uses are not generally within walking distance of residential areas, and they are not located in compact areas. This scattering of commercial facilities presents a major problem, especially related to traffic generation and visual disturbances along the highway.

Agricultural useage within the Canyon is limited primarily to grazing activities. There are many small farms in the area and a few large agricultural spreads. These are more accurately termed ranches, and several of these combine ranching with tourism. Montana's largest ranch, the Flying D, is located adjacent to the study area. The general pattern in Gallatin County shows the number of farms declining, along with a corresponding increase in acreage to those farms or ranches remaining. Most of the acreage in agricultural use produces feed for livestock. In the Canyon, this forage crop is generally used for on-site grazing practice. Both the Forest Service and private landowners issue grazing permits to allow their land to be used as pasture by others.

The U. S. Forest Service has jurisdiction over a large part of the study area. Recreational and scenic value lie in the expanse of forested areas in the Canyon. These forest lands should be utilized for their primary function of producing a renewable resource--timber, water, wildlife, grazing, and the other beneficial uses they help create. The open and barren or "park" land lying within the forested areas is also of significant nature in this mountainous region. The fact that precipitation is caught by these areas signifies the natural value of these lands. This open, park land, adjacent to forest land, is what makes the Canyon attractive.

Recreational usage in the study area is devoted to two general areas--dude ranching and general forest recreation. The U. S. Forest Service maintains several facilities within the area. Their attractions are oriented to fishing and overnight camping. Some trailer sites are provided. The private recreation sources are primarily dude ranches, resorts and cabin camps.
The Big Sky development, while not yet in operation, has begun the sale of recreation oriented residential units in its West Fork area.

Land Use Trends

In order to adequately measure land use trends which may provide guidance in projecting future land use and development, a body of data must be collected over a period of time. Only the most sophisticated planning agencies and governmental units take the necessary effort to compile these data. These data are not readily available in Gallatin County. Therefore, if any judgments are made, they must be recognized as being tentative and subject to reexamination and change.

"Considerable stability has been maintained in the Canyon, with dude ranching continuing to be a major occupation. Many of the early guest ranches have retained their names and some continuity of management. The establishment of primitive areas in the Spanish Peaks, and to the south in the Hilgard area has increased the attraction of the region for lovers of the real wilderness. A prolonged discussion has been under way concerning the maintenance of as much undisturbed beauty in the Canyon as possible.

A most recent and astonishing innovation in the recreational aspects of the Canyon has been the rapid expansion in the use of snowmobiles. The guest ranches now look forward to having as many or more guests in winter as in summer. A trail from the south of the Canyon to West Yellowstone is in the fourth year of marking and improvement, making it one of the longest and most spectacular mountain trails for snowmobile travel in the nation. In the meantime West Yellowstone, which within the decade was almost completely deserted during the winter, now claims the title of the Snowmobile capital of the United States. Annual meets bring competitors from the entire nation with more than 3,000 machines competing. The increasing facilities available in Yellowstone Park for winter travel by large and small snowmobiles is an additional factor in the expansion."*

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*Burlingame, (1970)

CIRCULATION

Vehicular circulation in the study area is carried by U.S. Highway 191, the Gallatin Canyon route from Bozeman to West Yellowstone. This is a two-lane, improved,all-weather highway that follows the Gallatin River. Several through routes intersect Highway 191 from the east and west; however, none of these intersections occur within the study area. There are several secondary roads providing access to the various drainage areas as well as snowmobile, pack, and hiking trails.

Regional traffic running between Bozeman and Yellowstone National Park and beyond tends to travel through the Canyon via this highway.

A principal traffic problem in the Canyon is generated by the heavy commercial truck traffic. This type of traffic is getting heavier, and causing increasing concern. Another problem identified by local residents is the lack of any posted speed regulation throughout the Canyon. At the present time high speed auto traffic, and lower speed recreation-vehicle and truck traffic create a definite conflict. Numerous accidents have occured as a result.

The Big Sky development will put an additional increase in traffic load on Highway 191. The results of a State of Montana traffic study in Gallatin Canyon show that:

> "The additional traffic generated by the Big Sky development will be principally winter traffic. At full capacity, the resort, when fully developed by 1980, it is estimated will generate 5,900 people per day or approximately 980 vehicles. The 1969 ADT (Average Daily Traffic) in February is 507 vehicles. The sum of these

> two figures is less than 1,500 ADT. The present Highway will carry 4,500 ADT. As far as we can presently determine and based upon the peak projected visitor days in 1980 and including the building of other facilities on or near the highway, the present highway will accommodate all foreseeable winter traffic.
>
> The 1969 summer ADT was 2,475 cars on an average July weekday. This traffic has been increasing at a rate of 43 cars per year. This projects to 3,181 cars per year by 1980 without Big Sky. Summer visitors generated by Big Sky will be approximately 50 percent of the winter visitors. If Big Sky summer visits are 3,000 visitors per day, this will result in 600 cars per day. The sum of these two figures equals 3,781 ADT by 1980. Likewise, it appears that the present highway will accommodate all foreseeable summer traffic."*

While the addition of the Big Sky traffic will not bring the average daily traffic figures beyond the present capacity of the road, it is strongly indicated that speed control will be absolutely necessary. Hopefully, realignments of the existing highway will not be necessary. Any additional widening of the highway in the Canyon would likely encroach on the river. This would be detrimental to the entire environment of the region.

The Big Sky development is currently served by a road designated as a State Highway Primary Stub, extending west from Highway 191. This roadway is being improved by upgrading and extension to carry it into the residential village developments of the project. The Montana Highway Department, the State Landscape Architect, the Forest Service, and the Montana Department of Fish and Game as well as County officials have been involved in the road design from the initiation of the project. Care is being taken to insure a blending of the roadway with the natural environment and to limit any possible adverse impact on the surrounding area.

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*Environmental Impact Statement, (1971)

There has been some recent talk of requesting construction of a highway from the West Fork area across the Madison Mountain Range to Ennis, thereby connecting Highway 191 with Highway 287. However, this does not appear likely in the foreseeable future.*

Public transportation facilities are expected to service the Big Sky development - particularly from both the West Yellowstone and Bozeman airports. The nearby proximity of these airports offers access to the area by those living outside the region. Indeed, a good number of people coming to this resort area will probably travel by air. Seasonal bus service also operates between Bozeman and West Yellowstone. Bozeman is served by Greyhound Busline, and two major airlines.

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* Letter from Montana Highway Commission, February 15, 1972 (See Appendix)

POPULATION

There are currently no heavy concentrations of population within the Canyon. Distribution is light and individual sites are rather remote from one another. During the summer months there is an influx of tourists to the fine guest ranches in the area. There are also a number of summer residents to the area. These influxes are small in themselves and are of a transitory nature.

Upon completion, the Big Sky development will provide the largest single concentration of people. The State Department of Planning and Economic Development makes the following population projection for Big Sky:

> "If the area is developed per the Big Sky master plan, the permanent population will increase, expecially at the Meadow Village. Big Sky's estimated employment of 300 persons may be composed of 150 commuters and 150 local residents. Of the 150 resident employees, one third or 50 persons may represent families living on Big Sky's land. These 50 families at 2-1/2 persons per family represent 125 persons which, together with the single employees, equals approximately 225 persons or population. In addition to the permanent population which will be generated from the resort employment, there will be condominiums and second homes built in the area. The condominium development and second home development will take place in both the Mountain and Meadow Village. Some permanent population will develop but the transient tourist population will be the over-riding population impact upon the area. This population may vary in the 1980's from 3,000 to a peak of 6,000 persons during the Christmas holidays or at Spring break."*

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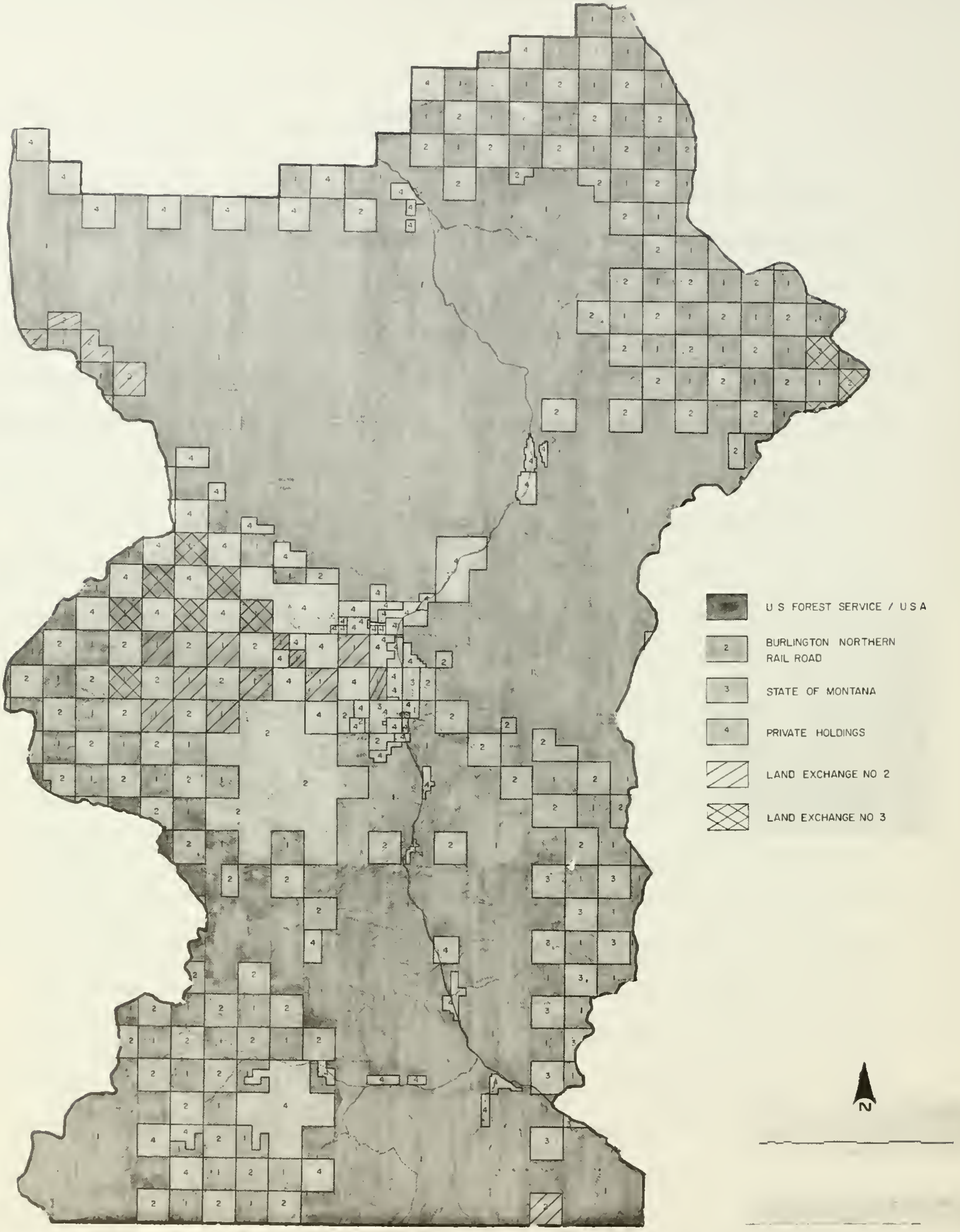
*Environmental Impact Statement, (1971)

LAND OWNERSHIP

Most of the land within the Canyon is held in ownership by two parties - the United States Government and Burlington Northern Railroad. Together they control approximately 80-85 percent of the land within the study area. The U.S. Government land is part of the Gallatin National Forest and is under jurisdiction of the U.S. Forest Service. The remaining acreage is divided among a relatively small number of landowners.

The accompanying land ownership map delineates the exact locations of the major property holdings, while grouping the more minor (in size) ownerships. The ownership information has been taken from the County Assessor's map books, and was compiled by Dr. Layton Thompson of the MSU-Study Team.

There are several Special Use Permits that have been issued by the Forest Service permitting vacation cabins to be located on public land. There are approximately 88 such permit holders in the Canyon. These permits are renewable periodically and they allow summer or vacation homes. Only a very small number of these are used as permanent residences. It has been Forest Service policy, for some time, not to issue new recreation home or special use permits. However, it is possible to obtain a permit by buying an existing cabin and gaining approval of the Forest Service for continued use. There has been a general decline over the years in the number of vacation homes located in the Gallatin National Forest.



LAND OWNERSHIP

GALLATIN CANYON PLANNING STUDY

Figure I-12

Land Exchanges

The accompanying land ownership map lists three land exchanges. One of these - land exchange No. 1 - is completed and has resulted in a transfer of holdings between the United States and Burlington Northern, Inc., successor by merger to the Northern Pacific Railway Company and others. The two other exchanges are between the same parties and are known as exchanges Nos. 2 and 3. These are currently in the process of approval. A final decision on these will probably not be reached before February, 1972.

> "The primary purpose of the exchanges is to consolidate lands within the Gallatin and Beaverhead National Forests and Yellowstone National Park to promote more effective and less costly land management. It will secure for the public certain scenic and recreation attractions, wilderness resources, and most of the remaining private lands within a municipal watershed."*

This major consolidation of lands on the Gallatin and Beaverhead National Forests has been studied by both parties since 1958. In addition to the privately-owned land in Yellowstone National Park, the United States proposed to acquire other lands that Burlington Northern owns within and adjacent to the Spanish Peaks Primitive Area, Tom Miner Basin, Bridger Bowl Ski Area, and the Hyalite Basin. In return, Burlington Northern wished to select lands in the West Fork of the Gallatin River which would be of value to the company and would help consolidate its ownership in that drainage.

Each individual exchange proposal has been carefully analyzed to determine the public benefits. An environmental statement on these exchanges has been prepared by the U.S. Forest Service, and may be referred to for a thorough discussion of these exchanges.*

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*Final Environmental Statement, (1971)

"There are 64,500 acres in the West Fork and Beaver Creek drainages where the National Forest lands selected in exchanges No. 1, 2, and 3 are located. Before exchange No. 1, the United States owned 32,640 acres or 50 percent. Burlington Northern owned 19,740 acres or 31 percent. Other owners accounted for 12,120 acres or 19 percent. If exchanges No. 2 and 3 are made, the United States will retain ownership of 18,340 acres or 28 percent. If Burlington Northern conveys three sections ... their respective ownerships will be 32,103 acres, or 50 percent, and 10,650 acres, or 17 percent. Other owners will have 3,400 acres or 5 percent.

Big Sky previously acquired 8,720 acres or 14 percent of the area from various owners other than the United States and Burlington Northern. It appears that some form of commercial development could take place in the West Fork regardless of the exchange outcome.

Over one-fourth of the West Fork and Beaver Creek will remain in public ownership and will include Lone Mountain and the slopes of the Spanish Peaks facing the West Fork. The present Spanish Peaks Primitive Area and the proposed Spanish Peaks Wilderness have somewhat different boundaries, but the exchanges were planned to eliminate private land within the boundaries and reduce the amount of adjoining private land."*

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*_Final Environmental Statement_, (1971)

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*Final Environmental Statement, (1971)

ECONOMIC CHARACTER

Natural Resources

The natural resources of the Gallatin Canyon region form the major attractions in the area. The Canyon's primary resource "value" is its natural scenic beauty - a natural landscape that is inestimable in its worth and seemingly boundless in its extent. It is fortunate that so far natural resources in the Canyon have not been unduly exploited for economic gain.

Many enjoy its scenery, whether on a leisurely sightseeing drive along Highway 191, or backpacking through the rugged wilderness. There are several guest ranches and guides available for tourists and visitors. With the number of Americans hungering for a chance to enjoy the beauty of nature increasing with each passing year, beauty spots of the country - like Gallatin Canyon - will be the destination of many travellers. We can expect there will have to be an increasing number of services to accommodate them.

Approximately 280,300 ± acres of the Gallatin Canyon planning study area is under U.S. Forest Service jurisdiction. Eight timber sales are currently under contract by the Forest Service for the harvesting of timber. These contracts are held by two purchasers and have termination dates running into 1974. They cover a land area of roughly 1300 acres plus. In keeping with their multiple use concept, the Forest Service determines the number of trees harvestable for a given year and the number of contracts are computed from these estimates.

The other largest holder of timber resources is Burlington Northern, Inc. This railroad company controls approximately an additional 68,500± acres of land in the study area. The company has a timber harvesting contract with the Yellowstone Pine Company that has several years to run before completion. An active harvest operation is being maintained under this agreement. Control and extent of cutting locations, as well as method of cut, is determined by the Yellowstone Pine Company.

Areas suited to livestock grazing are scattered throughout the Gallatin Canyon region. While a portion of these areas are grazed by various species of wildlife, commercial livestock grazing is also practiced. Private ranches graze primarily cattle and horses on private property. Grazing permits are granted by the U. S. Forest Service; under their multiple use concept, for grazing within the bounds of National Forest lands. The Forest Service determines the carrying capacity of the lands and grants grazing permits accordingly.

Minerals and Economic Geology

Major mining activities closed down prior to World War II. Mica, asbestos, and calcite were being mined in the study area. Mica mined on Squaw Creek, asbestos mined near Karst Ranch, and calcite extracted across from the Cinnamon Station have been active in the past and could return to activity given the right market conditions. In addition, scattered deposits of sand, gravel, stone (building as well as ornamental) and pumice exist but have limited potential for development.

The possibility of deeply buried gas and oil deposits should not be overlooked. However past and current explorations (leased property) have not thus far proven successful. The possibility of deeply buried low grade coal deposits also exists. Increased demands for fuel supplies and more detailed investigations may combine, to create a situation in which coal mining and/or oil extraction could become an industry. An additional, potentially developable mineral is phosphate, that is found in phosphate rock and phosphatic shales. Demands for fertilizers and chemicals may make this a developable mineral; however, the potential is somewhat limited.

One danger that exists, and accompanies mineral development in any area, especially on leased lands, is the lack of control of surface disturbances caused by mining and exploration activities. Increased public awareness of the associated problems of pollution and siltation of water courses, and vegetation removal and other scarring of landscapes, is demanding strict control to minimize these disturbances. The 1971 State Mining Laws provide some of the needed controls and regulations. Additional programs should be established to manage the potential development of these activities.

For additional information on the search for mineral wealth in the Canyon, the reader is referred to Burlingame.

UTILITIES AND RELATED SERVICES

The Canyon area is serviced with electric power and telephone connections by regional utility companies. Montana Power Company supplies electric power to the area, and maintains high voltage transmission lines into the Canyon. A recent installation brings additional power supply into the Big Sky development. Special care has been taken to utilize a power-pole for carrying overhead lines that is least obstructive to the surrounding environment. Mountain States Telephone supplies the entire area with telephone service. A soon-to-be-announced utility company merger will alter telephone service to the area. While the exact parameters of alteration are not known hopefully the current necessity for partyline connections will be eliminated.

Water supply and sewage disposal functions are taken care of at the local individual sites. Water is taken from wells or springs. The hydrology section of this report shows the location of some of these wells. Present useage does not utilize the full potential of the existing ground water resource.

For the Big Sky Development, water supplies will be derived from springs, wells, and streams. Water rights previously utilized for irrigation purposes on pasture and meadow lands are being utilized as this domestic water supply source. Total actual consumption of water for domestic use in the development will be less than previously used for agricultural purposes.

Sewage disposal in the Canyon is handled primarily through individual septic tanks or cesspools. A $1.2 million sewage treatment and disposal facility is being constructed for the Big Sky development. A special improvement district, designated Gallatin Canyon Special Improvement District No. 305, has been established for the construction, maintenance, management, and operation of this facility. It will in effect be a closed system - a series of interrelated ponds. This system, which will not result in any groundwater quality change, will utilize aerobic digestion of organic materials in aeration ponds, and a re-use of all filtered and sterilized effluent for the seasonal irrigation of the golf course facility.

According to a report* prepared by Morrison-Maierle, Inc., engineering consultants to Big Sky, -

> "The conservation of natural resources and environmental protection achieved by the proposed sewage treatment facility is outstanding. No facility within Montana, and only a few demonstration-type facilities in the nation, can measure up to the rigid criteria that have governed this design. The Big Sky facility, with the water re-use concept, will attain the highest degree of treatment and beneficial use of wastewaters of any method in practice to date."

Solid Waste Disposal

At the present time, there is no public disposal site operating in the Canyon. The previous disposal field, closed July 1, 1970, was operated by the U.S. Forest Service. Canyon residents either haul their garbage into Bozeman or West Yellowstone, have it hauled by a private firm, burn it, bury it on their own property, or illegally dispose of it in public litter barrels provided by the Forest Service at campgrounds. Solid waste disposal has been clearly recognized by residents of the Canyon as a problem needing immediate attention; however, creation of a solid wastes district appears to be questionable at the present time.

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*Environmental Reports as Related to Sanitary Sewage Collection and Treatment Facilities and Solid Waste Disposal Facilities, (1970)

Sanitary landfills have been proposed as a method of dealing with solid wastes for the Big Sky development, particularly for the first few years. Recommendations have been made by consultants to Big Sky to utilize the landfill method of solid waste disposal for several years until a larger volume of refuse is generated. It has also been recommended that consideration be given to the steps that may be taken to create a public solid waste district to serve the Big Sky and surrounding areas. A thorough review of the various possible methods of solid waste disposal was prepared for Big Sky, Inc., by Morrison-Maierle, Inc.*

Fire Protection

There is currently no fire protection service available to Canyon residents except as is available through agreement with the Forest Service. The individual property owner requests the service and voluntarily pays a fee for the protection. These fees are collected by the county along with the taxes, and are then turned over to the State Forester who reimburses the Forest Service. This service does not include structures. It seems to be generally agreed upon by Canyon residents that better arrangements should be made for fire protection.

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*Preliminary Studies and Report, Solid Waste Disposal, Big Sky of Montana, Inc., (1970)

The Gallatin Canyon Association has a committee studying the possibilities of improving fire protection services within the Canyon. Discussion has so-far centered around a proposed Volunteer Fire Department - similar to the one established at Galletin Gateway. Such a system works on funding strictly by donation.

The Big Sky development has plans for establishing a volunteer department. Their counsel has indicated they would be very glad to work on a volunteer basis with Canyon residents. With the Gallatin Gateway department to the north, and Big Sky, it is felt the Canyon will have good coverage within a year to 18 months.

Medical Services

The nearest health services, medical or dental, are located in Bozeman. There are none immediately available in the Canyon. Big Sky plans to have emergency first-aid facilities available in their development.

Law Enforcement

Law enforcement in the Canyon is rendered by the Gallatin County Sheriff's Office headquartered in Bozeman. One of the particular problems has been speed control on Highway 191. The Gallatin Canyon Association has been active in trying to correct this problem by notifying the highway committee.

Schools

There is only one school serving the Gallatin Canyon region, the Ophir School (School District #72). It serves grades 1 through 8, with one teacher for all eight grades. Bus service is not available and students attending grades 9 through 12 meet a Bozeman School bus at Beckman Flats. From there to school in Bozeman, the students have a twenty-five mile ride.

ECONOMIC HISTORY AND PRESENT ECONOMIC POSTURE

Industry

While mining played only a small part in the economic development in the region, there were some gold-placer operations along the Gallatin River at West Fork and Taylors Fork west of Eldridge. Early output is unknown but operations continued sporadically until 1945 even though annual output rarely exceeded a few ounces.

Amphilbole asbestos was recognized at Karst in 1901 but production has been sporadic, primarily because of marketing difficulties. Since the mine was acquired by the Interstate Products Company in 1947 a three mile access road to Highway 191 has been built and several hundred tons of crude ore produced.

Presently, industry in the Canyon is scattered and employs few people. In addition to the mines there is a concrete batch plant in the area. This is located immediately off the highway in the West Fork area. Most, if not all, of its current output is for the Big Sky construction development.

Tourism

With the exception of the now-building Big Sky development there is presently no large scale tourist industry in the Canyon. However, tourism is important to many of the Canyon residents. There are 28 dude ranches in the Gallatin National Forest, which encompasses more than the study area. Also in the National Forest are 29 resorts and cabin camps and 81 guides and commercial packers.

Within the study area, the National Forest operates 9 campgrounds and 3 picnic areas with a total of 70 units. With the addition of Red Cliff campground, 76 units will be added to the total. The Forest Service practices limited management on 145 identifiable unimproved camping sites. There are 14 commercial guides or packers with camp permits in the study area. Burlington Northern has served additional packer camp permits. Further additional numbers of commercial guides and packers make day use of National Forest land as part of their operation. Recreation use in all categories on the National Forest land within the study area in 1971 was approximately 96,900 visits with a total use of 194,100 visitor days. (A visitor day is one person visiting for 12 hours.)* A more detailed breakdown of the above information is available from the Forest Service Squaw Creek Ranger Station.

Within the canyon region itself the MSU Center for Environmental Studies team interviewed ten establishments, five of which were guest ranches and the others were dependent upon tourists for business. The guest ranches can accommodate between 200 and 225 persons each and are usually filled to capacity during their operating months. Not inclusive of guest ranches, there is sleeping capacity for about 350 and cafe capacity for about 150. Six businesses reported under $100,000 annual volume and four reported under $50,000. The businesses employ about 85 people during the peak two months of July and August, most of whom are local help and college students.

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*Cron, (1971)

In the three federal areas and the six state public outdoor recreation areas in the region, there were 2,681,250 day visitors (not to be confused with visitor days) and 145,200 over night visitors for a total of 2,826,450 visitors in 1970. Of course, these figures encompass a larger area than the study region, but with a total of 1,852,578 acres in the public domain (both land and water), the figures indicate that the visitation/acre ratio is low and one may assume that the same would be true in the study area.

Within the Gallatin National Forest there are three acres of beach, 78 acres devoted to picnicking, 16 acres accessible to boating, 280 acres for tent and trailer camping with 355 spaces, a capacity of 623 for group camping and areas available for skiing.

The addition of Big Sky recreation facilities to the Canyon, and the continued increase in anticipated travel and leisure-time throughout the United States, point toward increasing pressures on the Canyon in terms of out-of-state visitors.

Results of the MSU study indicated that there were an estimated 83,800 vehicles (of which 2,057 were sampled) passing through Gallatin Canyon during the period of July 24, 1970 to September 16, 1970.

LOCAL SERVICES

The businesses in the Canyon that provide local services are and have been primarily in business to serve tourists and guests at the guest ranches. The MSU team found that business owners in the region felt that little of their income was derived from the patronage of local residents. Available services, excluding guest ranches, motels or cabins and trailer courts, include cafes, service stations, propane dealerships, bars, a sporting goods store, and a market.

Early settlers in Gallatin Canyon recognized that the Canyon might hold an attraction for summer vacationers and the "dude ranching" industry was born in 1906. Three ranches were established including the West Fork Camp, the 320 ranch, and Karst Ranch. In addition to these, many others have opened and closed since 1907.

Recently, snowmobiling has become very popular and a long snowmobile trail has been established through the area. It is called the Gallatin Big Sky Snowmobile Trail. It runs roughly parallel to the Gallatin River,crossing it at Buffalo Horn Creek for 110 miles between Bear Creek to the north and Grayling Creek to the south.

Business is at its peak during the months of July and August; June is next in importance except for those places that cater to hunters. In those cases, September was listed as an important month.

The MSU study team has collected additional data regarding the present posture of businesses in the region. These data will include bank debits and deposits, the number and wages of members of the labor force in Gallatin County, vehicle assessments (truck and automobile), Montana Power Company electrical installations, service attachments, etc., and Mountain States Telephone service connections (commercial and private). The team plans to obtain additional business indicators such as the sizes, numbers and kinds of businesses in Bozeman, Belgrade, Manhattan and Three Forks. When all this information is available, it will be presented as a part of their baseline survey.

GOVERNMENTAL INFLUENCE REGARDING LAND USE CHANGES

Reluctant or eager attitudes toward a change in the land use pattern will reflect the nature and composition of the agency. To accurately assess what the attitude of each agency will be necessitates an analysis of the role and goals of the agency as well as a personal acquaintance with the people administering the agency. Obviously, those agencies which can see an advantage for their constituencies will tend to look with favor upon development; by contrast, those agencies which hold the public domain in trust may be more critical of development. Since it will be necessary to please all those involved, the goals and attitudes of all the agencies with jurisdiction in Gallatin Canyon will have to be considered by anyone contemplating a land use change.

LAND USE AND CIRCULATION ALTERNATIVES AND RECOMMENDATION

SENSITIVITIES ANALYSIS

ALTERNATES

COMPREHENSIVE PLAN

ENVIRONMENTAL SENSITIVITIES ANALYSIS

The resource inventory data that have been collected and summarized in this report have been analyzed in terms of sensitivities and implications to development. The sensitivity analysis has been used to develop a basic understanding of existing conditions and future potentials in the natural environment, with primary emphasis on existing and potential areas for recreation-community related development. The sensitivites analysis was then used to prepare alternate development concepts to establish a framework necessary for preparing the comprehensive plan.

The Gallatin Canyon landscape is the product of man's cultural interaction with the natural resource. Every land use development should consider the question of demand and the resolution of demand relative to supply. At the same time, consideration should be given to the entire question of manipulation of opportunities offered and constraints imposed by the natural environment relative to undesirable ecological consequences.

The environmental analysis process is divided into two subgroups, the natural constraints analysis and the cultural constraints analysis. The results of analyzing these two subgroups is presented in the land development sensitivities discussion. The basic premise employed in the analysis process is that each place in the landscape has an intrinsic suitability for certain land uses.

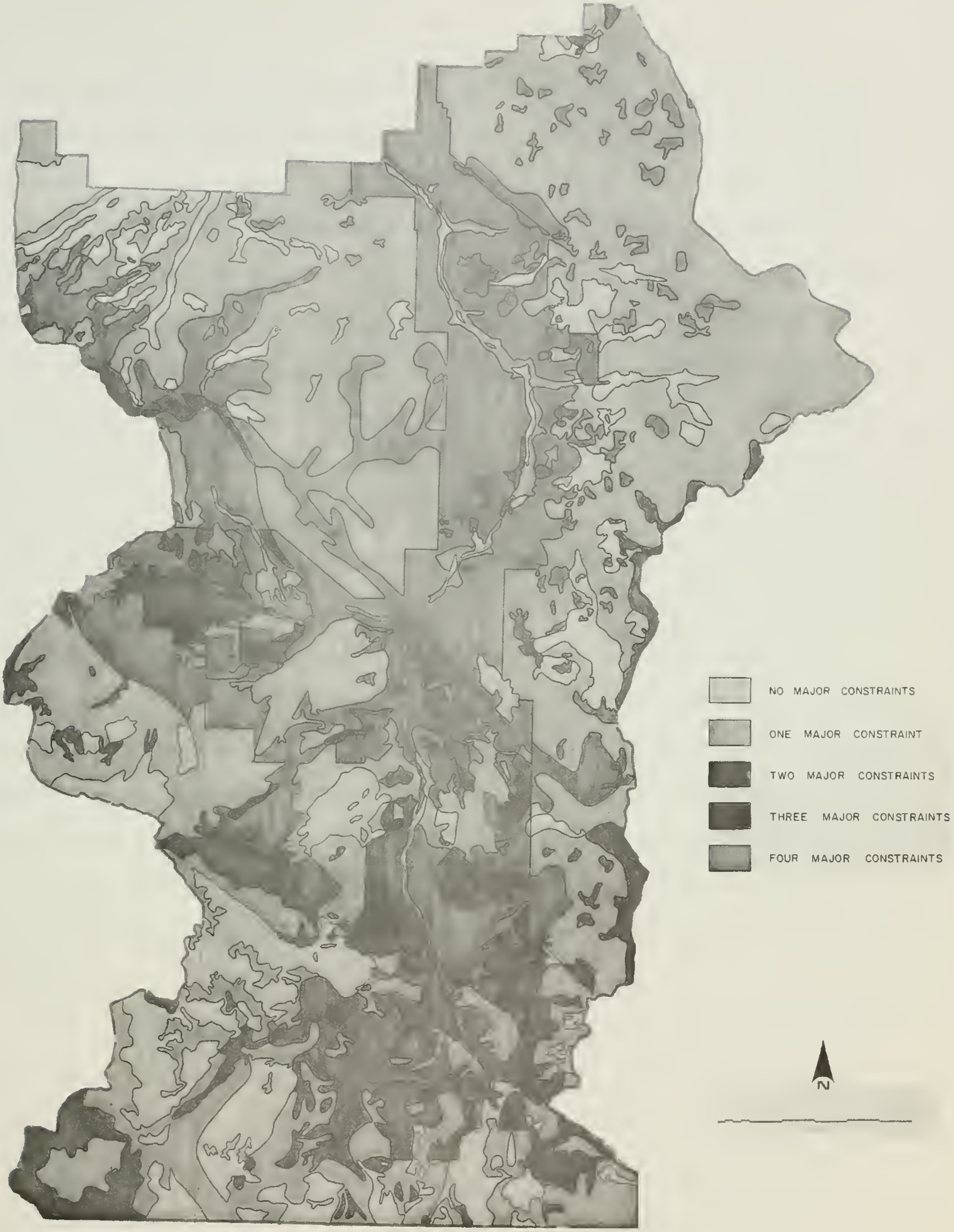
Natural Constraints. Characteristics of the natural elements of the environment--vegetation, geology, soils, topographic slope, wildlife--and their interrelationships have been analyzed in terms of the number of constraints they might present to development. These elements have been added in combination and superimposed, grouping areas with similar environmental sensitivities and related land use constraints. In order to collate the findings of the Environmental Resource Survey and to interpret them, all the land in the study area was valued with respect to each of the factors investigated. Judgments were applied to the categories within each element to distinguish between more important and less important factors.

Following application of the judgment, a Natural Constraints Map (Figure I-13) was prepared showing the results of superimposing the identified natural elements. The delineation of these areas should serve as a guide in the planning and development of Gallatin Canyon. It must be emphasized that all the boundaries are indicative, not definitive. Six categories were selected signifying the number of applied constraints.

Category	I	No major constraints
Category	II	One major constraint
Category	III	Two major constraints
Category	IV	Three major constraints
Category	V	Four major constraints
Category	VI	Five major constraints

The number of environmentally sensitive elements for each site, and the level of environmental sensitivity increases from one category to the next.

The area covered by available soils information presents a serious limitation on the delineated categories of the natural



NATURAL CONSTRAINTS

GALLATIN CANYON PLANNING STUDY

Figure I-13

constraints map. Other elements of the natural environment must also be considered such as hydrography and climatic considerations. These elements will affect any particular place in the Canyon, but have not been identified here as presenting significant major constraints to possible development.

Most of the area within the boundary of the available soils information has at least two major constraints (any two) of the identified elements). The Taylor Fork drainage area is delineated as having one to two operating constraints. More complete soils information--particularly on the limitations it may present to development--must be gathered for areas outside the context of information presented in the baseline report.

Any development in the Canyon should be understood to be contingent upon the development of a satisfactory source of ground water on the site for domestic uses. The disposal of liquid wastes will necessarily have to be investigated individually for each of the site areas too. The established migration routes used by elk and mule deer should be carefully avoided in development plans. Few of the identified natural constraints present an insurmountable problem to development, they only indicate areas requiring more specific consideration to the local environment.

Cultural Constraints. The natural constraints are the most important determinants in locating physical development on the study area, but not the only determinants. Characteristics of the cultural elements of the environment--land ownership patterns, existing land uses, and circulation patterns--have been analyzed in terms of the constraints they might present to development.

While existing land uses and circulation access present important constraints, the land ownership patterns are the real restricting element. Only approximately 30% of the study area is presently under private ownership. The accompanying Cultural Constraints Map (Figure I-14) indicates this ownership distribution. That land delineated as being under private ownership was judged as presenting less of a constraint to future development than the public holdings. Less of a constraint in this case meaning a wider possible range of potential land uses. The public lands, largely under the control and jurisdiction of the U. S. Forest Service, are expected to be developed under a multiple-use management concept.

The land exchanges currently under consideration (Nos. 2 and 3)* will add a considerable amount of acreage to the private ownership in the West Fork drainage--if they are approved. And these complete exchanges will result in one owner--Burlington Northern, Inc.--controlling most of the land in this drainage. This consolidation of ownership in the West Fork would result in less of a constraint to the future development potential of the drainage.

The Spanish Peaks primitive area, currently under consideration for designation as a wilderness area, is identified as a constraint in that no development or improvement will occur within this area. Another built-in constraint is applied to the total Canyon study area in the demands of limitation imposed by the

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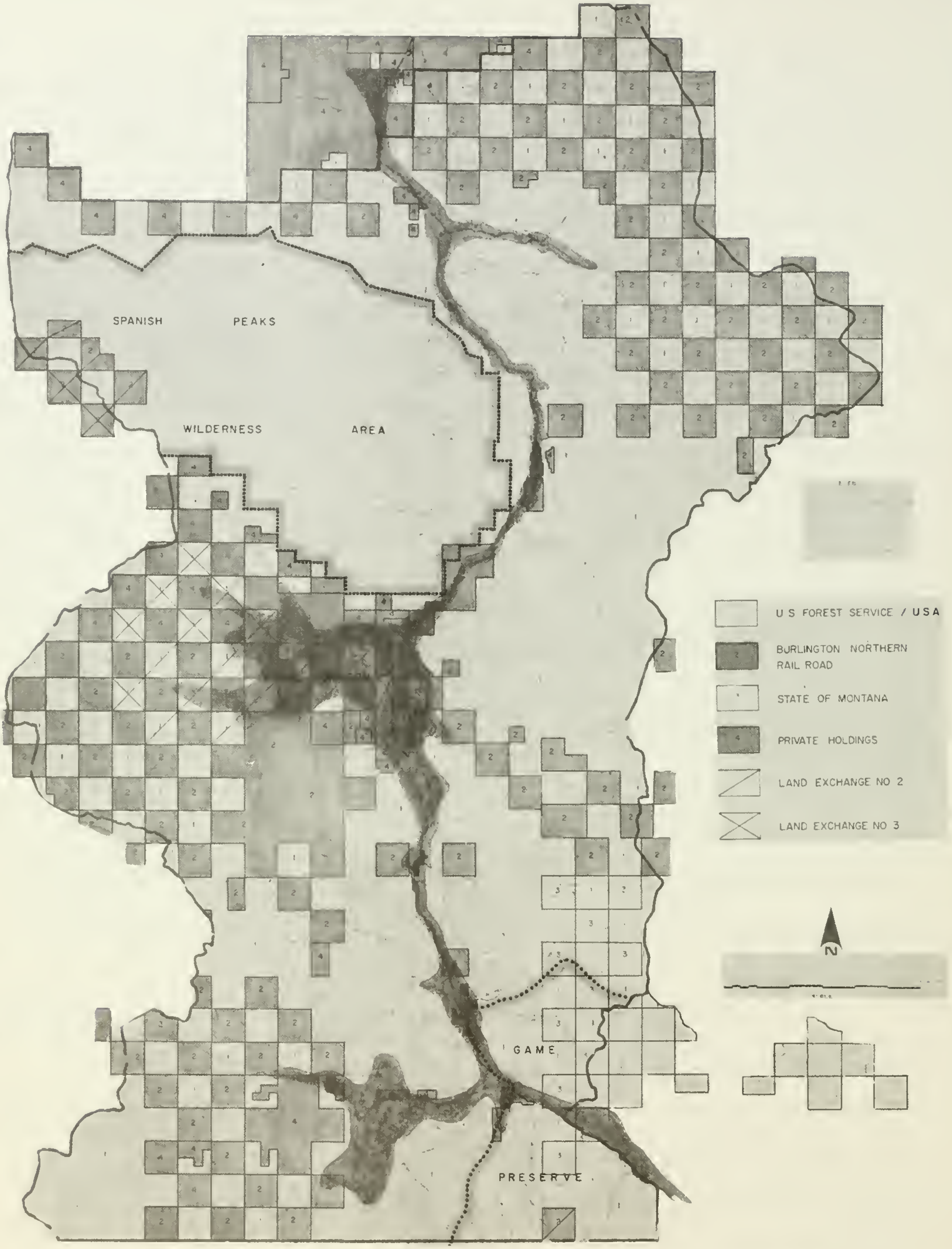
*Final Environmental Statement (1971)



CULTURAL CONSTRAINTS

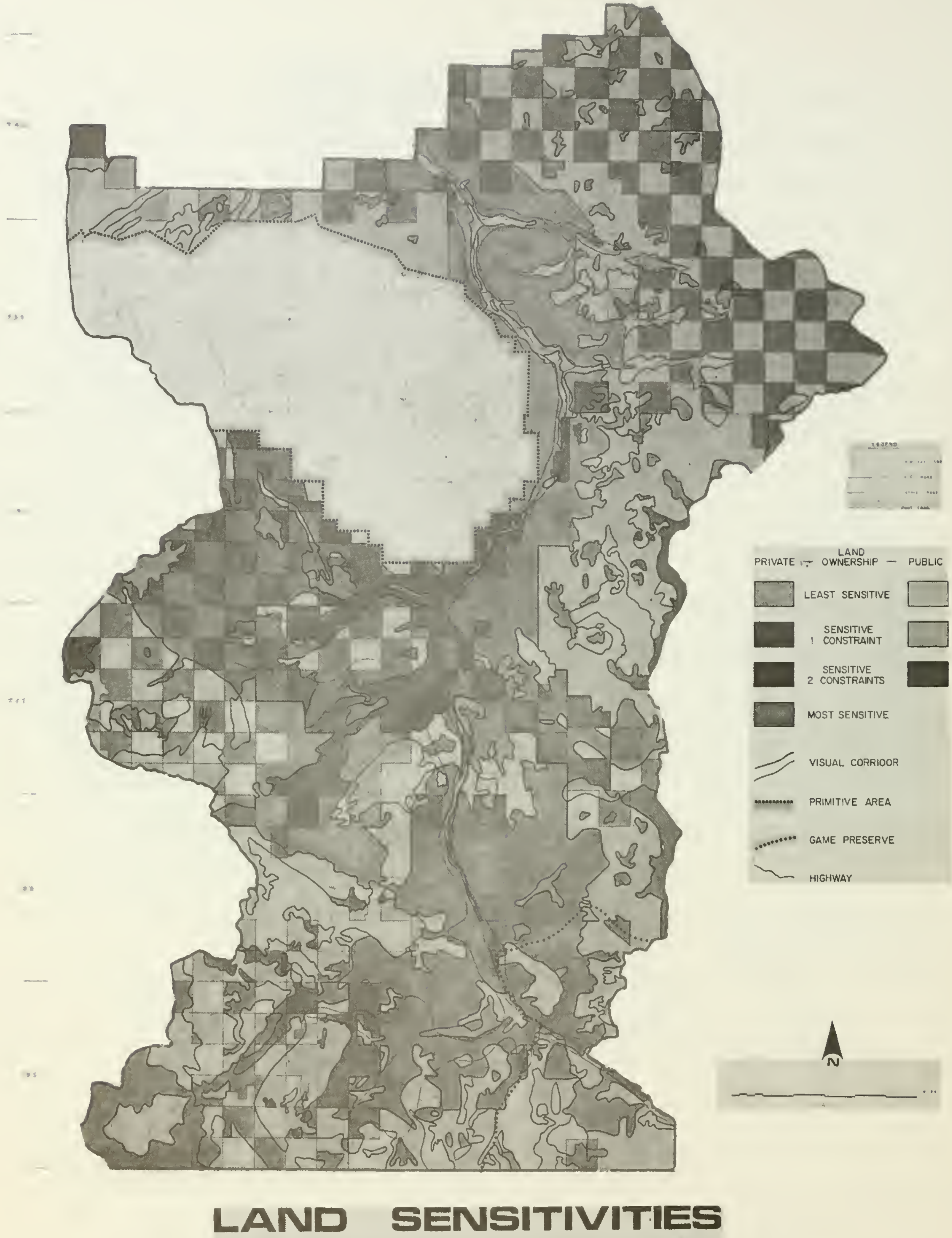
GALLATIN CANYON PLANNING STUDY

Figure I-14

citizens' committee on any improvements to Highway 191. One of the goals of the citizens' group is to keep Highway 191 as a two lane road. This definitely limits the amount of traffic this road will be able to satisfactorily carry.

Resource Analysis Conclusion

The Land Sensitivities Map (Figure I-15) combines both the Natural and Cultural Constraints Maps, presenting those areas that would be most sensitive to additional or new land use development. The degree of sensitivity is based on the number of identified constraining environmental elements, i.e., slope, soils, vegetation, ownership, etc. Areas are delineated from those having the least number of sensitivities (none) to those having the most number of sensitivities (three or more). They are also identified in terms of ownership patterns. It is apparent that most of the readily accessible lands present at least two constraints to further development. They may be in any combination of the identified environmental elements. While not necessarily presenting insurmountable problems, these constraints will demand individual attention in any detailed planning.



LAND SENSITIVITIES FOR DEVELOPMENT

GALLATIN CANYON PLANNING STUDY

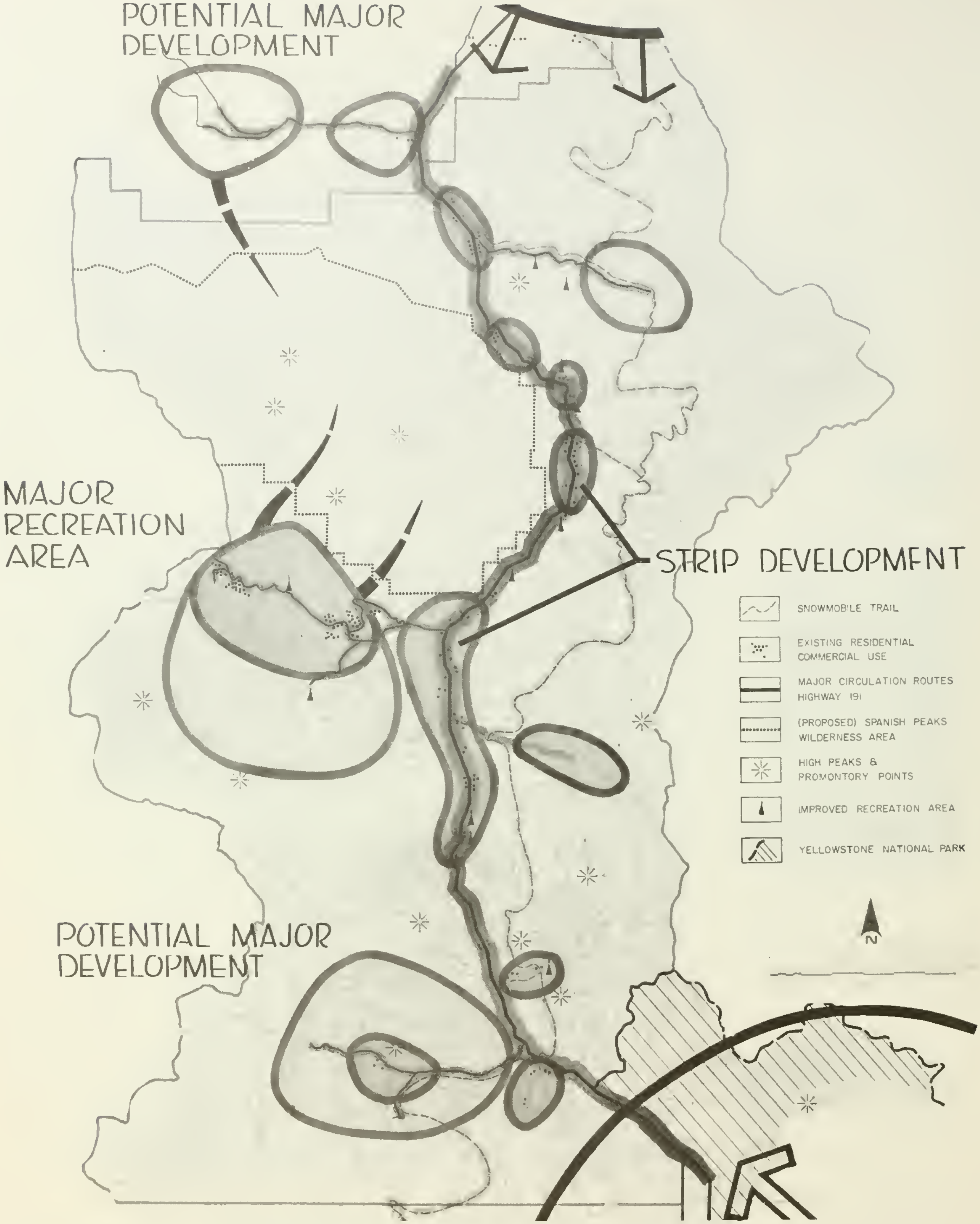
Figure I-15

LAND USE ALTERNATIVES

Regional Context. Gallatin Canyon is experiencing significant development pressures in the fields of forest recreation, resource extraction, and recreation-resort development. The natural resources of the Canyon capable of supporting development must be protected from improper utilization. With current recreation-resort facilities under construction, the West Fork area is experiencing the major development pressures.

There is a strong attraction to the Canyon from visitors to Yellowstone National Park located immediately south of the Canyon. Annual visits to Yellowstone have significantly increased over the last decade. This trend is expected to continue, if not accelerate, with increasingly available leisure time. The landscape and natural resources of the Canyon must be carefully developed in response to these potential visitations. Informal recreational activities such as hiking, fishing, sightseeing, scenic driving, and snowmobiling are dependent upon the fragile attractions of the landscape.

The recreation-resort developments in the West Fork area will exert tremendous pressures on all the natural resources--notably land, water, and vegetation. Largely as a function of the land ownership pattern in this area, if the proposed land exchanges are approved, the new land ownership pattern will provide the potential for additional private development. The adjacent Spanish Peaks Primitive Area can be expected to continue to experience heavy use demands, and there is the additional potential for private development expansion north of the primitive area.


POTENTIAL MAJOR DEVELOPMENT
MAJOR RECREATION AREA
STRIP DEVELOPMENT
POTENTIAL MAJOR DEVELOPMENT
SNOWMOBILE TRAIL
EXISTING RESIDENTIAL COMMERCIAL USE
MAJOR CIRCULATION ROUTES HIGHWAY 191
(PROPOSED) SPANISH PEAKS WILDERNESS AREA
HIGH PEAKS & PROMONTORY POINTS
IMPROVED RECREATION AREA
YELLOWSTONE NATIONAL PARK
N

INFLUENCING PRESSURES

GALLATIN CANYON PLANNING STUDY

Figure I-16

Alternate Development Concepts. The Canyon has the resource potential to handle additional land use development--principally recreation oriented. Three alternative land use concepts were developed to demonstrate potential development possibilities for the Canyon. The first allowed full development potential while respecting the natural constraints. The second provided for a continuation of present trends with no further developments, and assumed no land exchanges. The third was a composite of the first two placing clustered development to be consistent with the identified natural and cultural sensitivities. The alternatives individually did not entirely reflect the adopted citizen goals, but rather they recognized the inconsistencies among these goals and expressed public comment.

The three alternative land use concepts were examined in terms of their probable effect on development within the study area and their resultant effect on the total environment. The purpose of reviewing these alternate concepts was to establish a framework for the preparation of the comprehensive plan. These review comments were constructed in relation to the planning goals and objectives adopted by the Gallatin Canyon Planning Study Committee. From the directions indicated, a Synthesis Concept (Figure I-17) was produced drawing together elements present in each of the three alternatives.

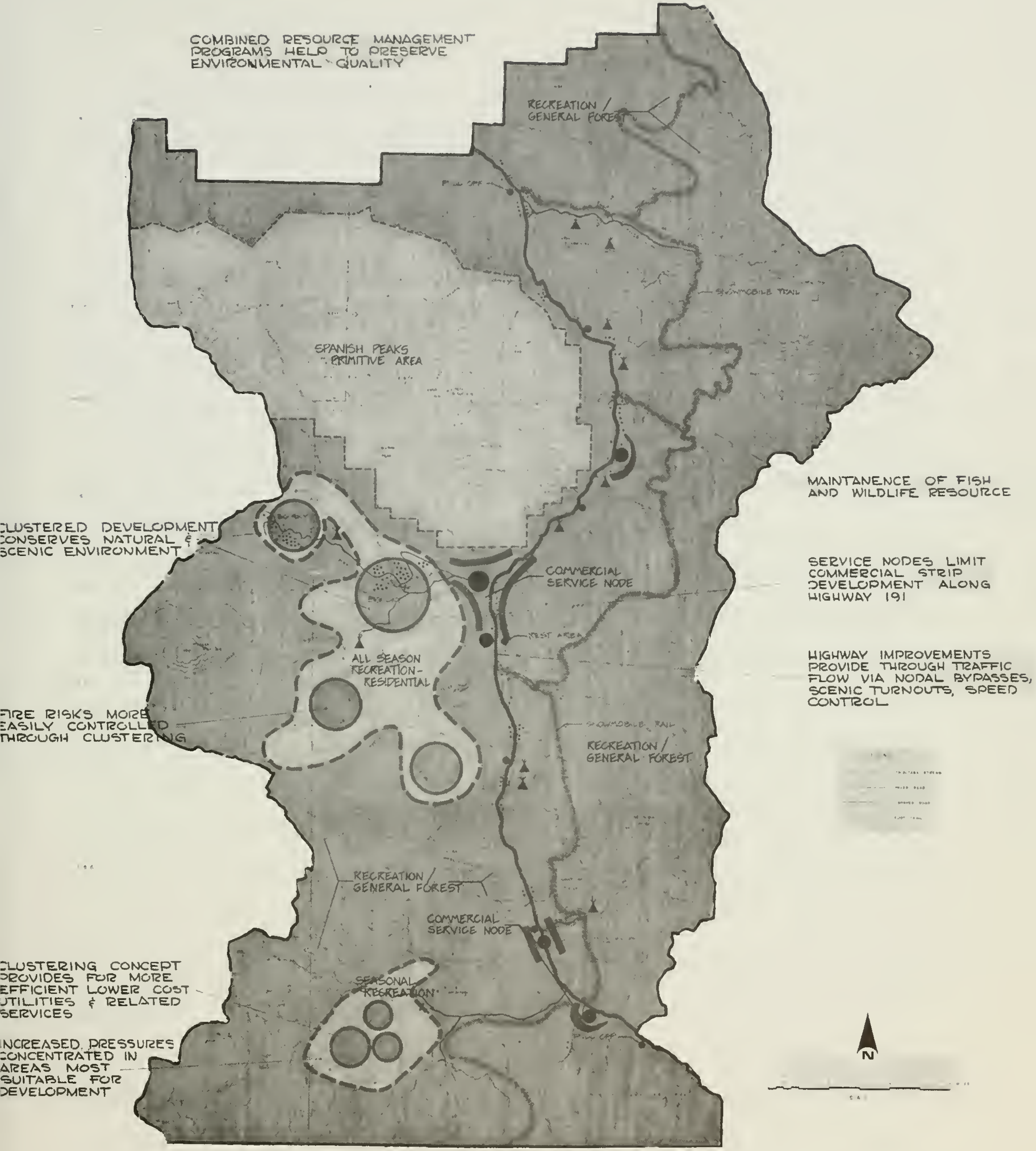
Alternate Synthesis Concept

This Synthesis Concept calls for consideration of the Canyon as first and foremost a scenic area, recognizing the unique natural attractiveness of this region. It allows for utlization of the probable development potential while respecting the natural environmental sensitivities. It assumes completion of land exchanges 2 and 3 resulting in large privately owned holdings in the West Fork drainage. And, it demands the utilization of natural resources to be governed by the overriding desire to preserve the natural and scenic environment, with the development of coordinated land management programs designed to carry out a multiple use program.

The concept necessitates improvements to Highway 191 to accommodate better traffic movement, but with no expansion of the highway beyond the two land concept. More pullouts and rest areas for truck and recreation vehicle traffic would be provided. It also assumes the eventual establishment of a through highway connection to the Madison Valley via the West Fork drainage area.

The Synthesis Concept further calls for the clustering together of any significant development, minimizing visual intrusion upon the landscape, lessening construction and maintenance costs, and limiting interference with the natural ecosystems. The concept provides for commercial services to be clustered in nodes of development at significant points along Highway 191--the major node occurring at the West Fork junction to serve that potential growth area.

A combined multiple-use management program for public and private land would be initiated to facilitate the administration of common objectives in the utilization of natural resources. While recognizing a past history of a lack of cooperation between public and private interest groups, proper management of natural


RECREATION / GENERAL FOREST
SNOWMOBILE TRAIL
SPANISH PEAKS PRIMITIVE AREA
COMMERCIAL SERVICE NODE
REST AREA
ALL SEASON RECREATION-RESIDENTIAL
SNOWMOBILE TRAIL
RECREATION / GENERAL FOREST
RECREATION / GENERAL FOREST
COMMERCIAL SERVICE NODE
SEASONAL RECREATION
N

COMBINED RESOURCE MANAGEMENT PROGRAMS HELP TO PRESERVE ENVIRONMENTAL QUALITY

CLUSTERED DEVELOPMENT CONSERVES NATURAL & SCENIC ENVIRONMENT

FIRE RISKS MORE EASILY CONTROLLED THROUGH CLUSTERING

CLUSTERING CONCEPT PROVIDES FOR MORE EFFICIENT LOWER COST UTILITIES & RELATED SERVICES

INCREASED PRESSURES CONCENTRATED IN AREAS MOST SUITABLE FOR DEVELOPMENT

MAINTANENCE OF FISH AND WILDLIFE RESOURCE

SERVICE NODES LIMIT COMMERCIAL STRIP DEVELOPMENT ALONG HIGHWAY 191

HIGHWAY IMPROVEMENTS PROVIDE THROUGH TRAFFIC FLOW VIA NODAL BYPASSES, SCENIC TURNOUTS, SPEED CONTROL

ALTERNATE SYNTHESIS

GALLATIN CANYON PLANNING STUDY

Figure I-17

resources in the Gallatin Canyon will necessitate an improvement in relations. The suggestion of a combined multiple-use management plan, called for in the adopted planning goals, could act as a vehicle toward improving cooperation.

This synthesis concept most closely follows the adopted planning goals in terms of: protecting the existing ecosystem from unnecessary alteration and disturbance; developing coordination among government agencies and private parties; and preparing land use patterns to enhance the environment of the region. Although changes must be expected in the natural environment, the clustering concept provides the best means of accommodating anticipated growth and minimizing its impact upon the natural ecosystem. This concept would accommodate the adopted planning goals and objectives to safeguard the environmental attractiveness of Gallatin Canyon.

COMPREHENSIVE PLAN

The Comprehensive Plan is the graphic document setting forth policies that will guide the physical growth of Gallatin Canyon. This plan, in itself, is not a legal document restricted to any particular political jurisdiction; rather, it is concerned with the uses of land, the distribution of population, the intensity of building development, and the facilities for circulation that will affect all of the Gallatin Canyon planning area.

This Comprehensive Plan is general and as such, presents the approximate locations of broad types of land usage and the major elements of the Canyon circulation system. The Plan is not a specific design, but a diagram reflecting broad major development policies. The Comprehensive Plan is intended to guide growth in an active, decision influencing, action-oriented way. It will provide a base to test the logic and consistency and measure the impact of current development against the adopted citizen planning goals and the canyon environment.

It should be emphasized that the Comprehensive Plan is general; that is, it is an outline for harmonious and coordinated development, and not a rigid framework. Plan policies are stated to provide the widest possible range of choice for future specific actions and decisions. The range of choice is expected to guide decisions along a general course of development in line with the expressed goals and desires of the citizens.

The planning problems in the special environment of Gallatin Canyon are dictated by its physical limitations, limited access, climatic variations, and high percentage of land (71%) in public ownership. Implementation and management solutions will require close cooperation and coordination among all parties and agencies, both public and private.

The Comprehensive Plan consists of three elements appearing on the graphic plan following the end of this section. The plan elements, which are described in the following pages, include:

Land Use Element;
Circulation Element; and
Public Service and Facilities Element.

LAND USE ELEMENT

The Land Use Element of the Comprehensive Plan is the key element setting forth the pattern of basic uses of land for the entire plan. The land use elements have been developed within the identified land constraints and sensitivities, and in relation to the citizen adopted general planning goals. As detailed planning studies are developed in the future, these land classifications will be more specifically defined in terms of detailed uses relating to the general category. To facilitate a clearer understanding, the Land Use Element has been divided into five sections:

1. Natural Areas;
2. General Forest Areas;
3. Residential Area;
4. Commercial Areas; and
5. Recreational Areas.

Natural Areas

The Natural Areas Section has been placed forefront of the Land Use Element to emphasize priority consideration. The plan designates those areas recommended as permanent open space and then considers the rest of the area for other uses. This policy is in line with the basic adopted planning goals.

Natural Areas are generally described below followed by general policy statements to be used as a guide to detailed area planning.

Riparian Areas. These encompass the permanently wet areas and flood plains associated with the Gallatin River and its tributaries. The area represents unique associations within which a delicate balance exists between water, soils, vegetation, and wildlife. Minor disturbances have the potential of destroying these unique areas. In accordance with the goals of preserving stream and river channels from unnecessary alteration and disturbance, it is recommended that all uses within riparian areas be strictly controlled.

Primitive (Wilderness) Area. This area encompasses the designated Spanish Peaks Primitive Area classified under U. S. Forest Service Regulation L-20. This area is shown on the Comprehensive Plan as the Spanish Peaks Primitive Area, probably soon to be classified the Spanish Peaks Wilderness Area. The area has been set aside as a significant place deserving preservation in the local surrounding environment and lies totally within National Forest Lands (assuming the favorable completion of land exchange #2).* This area is proposed to continue in its present use, dispersed recreation, and to be further improved only as deemed necessary by the governing agency.

High (Elevation) Areas. This category, corresponding to the Forest Service Management Zone, "High Area," is characterized by high, rugged peaks and open ridges with scattered timber. "This zone is an important producer of water and regulator of stream flow. . . .Geologic erosion is prevalent everywhere in this zone and without doubt contributes the greatest amount of silt to the Gallatin River."[1] These areas are shown on the Comprehensive Plan as High (Elevation) Areas, and it is the intention of this Plan that these areas be utilized only for back-country type activities. Primary emphasis should be given to the protection of these areas as watersheds.

The following specific policies should be closely followed to help preserve Natural Areas:

1) Manage primarily for environmental protection and protection and recreational use, emphasizing maintenance and enhancement of the natural beauty;

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* See Land Exchange, p.

[1] U.S. Forest Service Multiple-Use Management Plan.

2) Avoid developing those areas subject to possible flooding or erosion;

3) Provide for permanent public access;

4) Direct timber management objectives toward retaining the natural character of the environment;

5) Limit vehicular circulation to parking and other road-end facilities necessary to provide access;

6) Expand trail system and related facilities to provide for the full use and enjoyment of each area; and

7) Provide protection to all historic and scenic sites, and to all areas of geologic and archeologic importance.

General Forest Areas. One of the major objectives of the Comprehensive Plan is to protect the timber resources and scenic beauty of the Canyon. Once the area is consumed for other uses, it cannot be replaced. These areas are shown on the plan as General Forest Areas. It is the intention of this Plan that these areas be utilized by public or private agencies and owners in such a way that the existing amenities are not destroyed. The major use activities occuring in this element are the production and use of timber and forage, and dispersed recreation uses.

Within the General Forest area a considerable number of resources and land use values are present. The area contains a rich variety of vegetation, topography, climate, scenic beauty, and wildlife. It produces important quantities of water for streams and underground storage.

It is the intention of the Comprehensive Plan to protect and preserve the general scenic quality of the Canyon by making policy recommendation and development guidelines as called for in the adopted planning goals. Key to the quality preservation of this unique area is the initiation of a combined multiple use management program covering both public and private lands. Initiation of such a program is strongly recommended for the Canyon and should include the recommendations contained herein for forest management.

The following specific policies should be established to help preserve this General Forest environment:

1) Provide close cooperation in the utilization and management of both public and private lands through the development of and adherence to a combined Multiple Use Management Plan, one that clearly recognizes the potential of the land, but that is also addressed to environmental quality protection;

2) Give low priority to non-related land use activities, activities not directly related to timber resource management, foraging activities, and dispersed recreational activities; and

3) Adhere closely to the development planning and design guidelines suggested in the following Section of this report.

Residential Areas

The general planning goals call for providing additional residential land use areas and that these be areas that enhance the relationships between development and the natural environment. Correspondingly, the Comprehensive Plan designates areas most desirable for residential development in terms of the identified land constraints and sensitivities. It is not the intention of the Comprehensive Plan that residential development should occur only in the designated areas. However, they are designated as those areas most suitable for development under the identified parameters. They are meant to be used as a general guide in locating structures in the Canyon.

To reach the goals of maximizing the attractiveness of the developed areas and protecting the special scenic character, specific developments must be planned with care and imagination. Specific guidelines for residential development are outlined in this report in the following chapter. The local environment can best be protected by utilizing the clustering-concept of site design. It is recommended that such development be placed so as not to interfere with open meadows, and to be placed well away from the wetland areas adjacent to stream channels.

The over-all controlling element in terms of recommended residential density is the expressed planning goal to keep Highway 191 a two-lane facility. Generally the residential areas indicated on the plan are expected to accommodate one dwelling unit per 10 acres. Here the clustered housing concept which minimizes the impairment of scenic values is essential to accommodate potential growth.

The general land use concepts and development guidelines for residential development are presented in the Comprehensive Plan to:

Determine the location of future development and the general density levels;

Serve as a basis for guideline standards; and

Identify areas of conflict with existing development.

It is a recommendation of this plan that residential development adhere to the following general policies:

1) Cluster concepts of design should be utilized for construction to reduce unnecessary visual impact upon the environment;

2) Future residential development should be limited to adhere to the expressed goal of keeping Highway 191 a two-lane facility;

3) Residential development should be located to avoid open meadows and keep away from riparian areas; and

4) Development should closely adhere to the development planning and design guidelines suggested in this report.

Commercial Areas

The Comprehensive Plan includes the recommendation that all future commercial development and services be located in a series of "nodes" of settlement separated by expansive open space to provide definition and preserve the environmental quality. Optimum locations for these facilities have been designated at several points along Highway 191.

Specific commercial land uses, and their functional, quantitative, spatial, and chronological aspects are not presented in this plan. Future commercial uses should identify with those facilities and attractions that mutually support the recreational land uses and that provide needed services in the Canyon. These elements should be established on the basis of needs for various types, in certain locations, of certain capacities, and within the development guidelines. The most important consideration in terms of commercial areas relating to this Comprehensive Plan is the concept of nodal development. By limiting the spread of service facilities and separating the various "nodes" with expansive green areas there will be a minimum of intrusion into the landscape. Specific development guidelines are presented in the following chapter.

The following policy statements present the major features of commercial area developments:

1) Encourage all commercial development to cluster in "nodes" of dense concentration along Highway 191 as shown on the plan. Do not continue strip development along the highway;

2) Recognize existing commercial facilities as part of the over-all pattern, but encourage only very limited expansion outside the identified "nodes";

3) Encourage retail facilities and service types that will support land uses identified with the Canyon (e.g.; recreational development); and

4) Follow the design and development guidelines suggested in this report for commercial and service development.

Recreational Areas

The Comprehensive Plan is based on the recognization that natural features of the land predetermine the appropriate sites for establishment of recreational and open space areas. Although the pressures for recreational use are intense and the variety of recreational potentials great, few active recreational land use areas are proposed in the Comprehensive Plan. There are significant environmental limitations constraining recreational development; but circulation and accessibility into and through the Canyon is the major limiting factor. Those categories most appropriate as major recreational areas are:

Dispersed Recreational Activities. Dispersed recreation activities are indicated on the plan as occurring within the General Forest area. The basic concept for these areas is to maintain a natural landscape. Only those facilities needed to compliment dispersed recreation activities (e.g., trails) or to protect the natural environment are recommended. The effort should be to control access and facilities, thereby limiting the number of recreation users.

Commercial Recreation. This category shows areas recommended for active recreational developments. Uses primarily oriented to recreational opportunity including overnight campgrounds, guest ranches, and incidental residential uses will be appropriate for these areas. The intention is to concentrate active recreational development in areas where it is most compatible with the natural environment, thereby maintaining the present scenic character.

Trails. An expansion of the existing trail systems would be most appropriate to the need for providing more recreational opportunities and the concept of dispersed recreation. It is the intention of the Plan that both public and private agencies and owners cooperate in providing connective trail systems throughout the Canyon. Specific policy statements concerning trails are contained under the Circulation Element.

It is the general goal of the residents to control the development of recreational land uses in the Canyon and limit them to activities which depend upon, and are compatible with, retention of the area's natural character. The following policies should therefore guide the development of recreational land uses:

1) Provide for only those facilities which are compatible with the area's natural landscape;
2) Limit the further development of public recreation facilities to be consistent with the adopted citizen planning goals;
3) Provide improved access and road-end facilities to all areas of recreational attraction; and
4) Plan recreational facilities to be consistent with the recommended development planning and design guidelines.

CIRCULATION ELEMENT

This element of the Comprehensive Plan presents a description of the basic circulation system for the Canyon. A major limiting factor on the future land development in Gallatin Canyon is the strongly expressed desire of residents to restrict construction activity on Highway 191 to normal maintenance and minor improvements. This objective means that the highway will be kept to a two-lane facility, with a maximum carrying capacity figure of 4,500 vehicles per day (estimated by the Montana State Highway Department).*

The Comprehensive Plan indicates only the major elements of a circulation system for the Canyon, and does not attempt to program anticipated construction. In order to insure fulfillment of the goals and objectives of the Comprehensive Plan, it is the recommended policy to:

1) Promote and encourage the orderly and timely development of the general circulation throughout the Canyon;

2) Program balanced expansion of the Canyon circulation system in terms of both need and the expressed planning goals;

3) Analyze thoroughly the impact of specific highway improvements on the Canyon environment prior to any actual construction activity;

4) Utilize the concept of low-speed recreational and scenic roadways to preserve and enhance the scenic and cultural values of the existing area environment;

5) Provide the recreation traveler with many opportunities for a variety of experiences by providing access to supplementary areas and attractions through secondary roads branching off Highway 191;

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* See p. 132

6) Discourage incompatible traffic where possible by offering alternate routes more attractive to commercial or through traffic;

7) Ensure that the aesthetic character of all cultural elements along the highway are of the highest attainable, including both those publicly and privately owned; and

8) Provide a maintenance program to maintain the integrity of the surrounding environment.

Each of the major components of the Circulation Element are described in the following paragraph.

Highway 191

State Highway 191 handles all vehicular traffic going through the Canyon. This highway will continue to be the main element in the system. Improvements to the road should include roadside rests, turn lanes, pedestrian crossings, signed animal crossings, traffic signing, and speed control. The following policy statements outline specific objectives:

1) Site planning, architectural and landscape design of adjacent development should result in an attractive appearance from the highway and a harmonious relationship with the surrounding landscape;

2) Development along the highways should give particular attention to the node-concept of site planning as expressed in the plan. Development should relate to such conditions as:

   Limiting access onto the highway,
   Clustered development,
   Setback requirements,
   Screening,
   Underground utilities, and
   Appropriate appearance of advertising in relation to the environment,

3) Improvement to Highway 191 should be designed to provide the maximum pleasurable driving experience rather than to facilitate high speed travel;

4) Roadside rest areas and scenic viewpoints should be developed at relatively frequent intervals where local site conditions are compatible. Specific locations should be approved by local jurisdictions and the State Highway Commission wherever their jurisdictions are compatible in accordance with existing law; and

5) Maximum daytime speed control of 55 mph should be established for Highway 191 as it traverses the study area and that this limit be actively enforced by the appropriate governing agencies.

Proposed Highway to Madison Valley

A highway to connect the Ski Village near Big Sky and the Madison Valley near Ennis has been proposed, and is included here as a possible future element of the circulation system. The highway has not been located to date and has not been placed on any approved Federal Aid System*;consequently, it is shown on the plan as only a diagrammatic connection to the Madison Valley. If constructed, this highway will allow improved access to Big Sky and will most probably relieve congestion on 191. It is a recommendation of this Plan that design concepts for all proposed highways adhere closely to the development guidelines suggested for Highway 191.

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* Letter from Montana Highway Commission, February 15, 1972 (See Appendix)

Trail Systems

The existing trail systems cater to hiking, equestrian, and snowmobile use. It is a recommendation of this plan that no new major trail systems be added and that future development be held to improving existing trails, trail linkages, and related facilities.

It is the recommended policy to:

1) Pursue a Canyon-wide land management program, facilitating as one element of multiple use the improvement of trail systems throughout the Canyon;

2) Prepare and effectuate, concurrent with the above activity, a comprehensive trail systems plan serving all recreational interests but one responsive to the natural environmental sensitivities; and

3) Confine snowmobile recreational activity to designated roads and the existing Big Sky Snowmobile Trail and provide for no further expansion of this trail system.

PUBLIC FACILITIES AND SERVICES ELEMENT

Public facilities and services in Gallatin County are provided in various ways through a combination of units of government and privately owned utility services. Traditionally public utilities and services have been provided to meet the needs of the expanding community for the purpose of protecting the public health and welfare. Since the planning goals of this study give prime consideration to resource conservation, environmental protection, and ecological stability, the following recommendations have been formulated to correspond to these considerations.

The conclusions in the Resource Survey of this report indicate that responsibility to meet the expanding needs for public services will be borne largely by private parties. Sanitary waste disposal and water supply will necessarily be taken care of at local, individual sites. Solid waste disposal, fire protection, and improved medical services are also elements that will be largely left to private parties to organize.

Water Supply

It is anticipated that water supply for domestic purposes will continue to be taken from ground and surface sources. Individual developments will be expected to provide the necessary service. Careful consideration should be given to the environmental impact that might be created by specific developments and utilization of the water resources.

To assure an adequate supply of high quality water for the future needs of Gallatin Canyon, the following policies are recommended:

1) Consider the impact on fish, wildlife, vegetation, and all other elements of the natural environment and provide for their protection in all water supply development;

2) Establish water quality baseline parameters to measure and monitor possible pollution of the surface streams and aquifers in the Canyon and take caution to avoid their pollution; and

3) Provide adequate water supply and waste water treatment in adherence to guidelines set by the Montana State Department of Health in all future high density developments.

Sanitary Waste Disposal

Like the water supply, sanitary waste disposal will be the responsibility of each individual development. The same degree of attention should be given to the environmental impact of sanitary waste disposal as that given to development of water supplies. Full ecological and environmental consideration must be given to alternatives of sewage processing and disposal.

The following policies regarding sanitary waste disposal should be followed to reflect the adopted planning goals:

1) Avoid waste management practices that could cause an adverse impact on fish, wildlife, vegetation, and all other elements of the natural environment and provide for their protection in all waste treatment development;
2) Consolidate where possible waste treatment services into an integrated system;
3) Encourage cooperation and communication in solving management problems; and
4) Monitor waste effluent disposal in the streams and rivers of the Canyon and compare against established baseline parameters.

Solid Waste Disposal

Currently there is no system for solid waste disposal other than the sanitary land fill proposed for the Big Sky development. The problems of waste disposal have been clearly recognized by residents of the Canyon and it should be a prime responsibility of these residents to investigate a means for handling disposal. It is a recommendation of this plan that no further disposal fields or land fill sites be located in the Canyon.

Some consideration should be given to approaching the solid waste disposal question on a county-wide basis. Waste transfer might be placed in strategic locations. These might be local facilities where refuse would be deposited by collection vehicles and individual citizens. As technology improves new methods of refuse management and disposal will provide alternate choices for future action.

Concerning solid waste disposal services, it is recommended:

1) To continue monitoring illegal disposals on public and private land;

2) To continue searching for long-range solutions to solid waste management, emphasizing environmental protection; and

3) To provide supervision of all refuse collection and disposal activities in the Canyon.

Fire Protection

Fire protection service is currently not available to Canyon residents except by agreement with the Forest Service. Discussions between the Gallatin Canyon Association and Big Sky, Inc., have indicated the possibility of establishing a mutual aid agreement through a volunteer fire unit (see p.146). This type of locally coordinated agreement would best serve the interests of all concerned.

Of the many factors controlling fire protection, only the location of stations is within the direct scope of this plan. Present and proposed land use patterns indicate the volunteer station-unit planned for location at the Big Sky development could adequately serve the West Fork area (especially on a community volunteer basis). Proposed land use patterns outside the West Fork area do not indicate concentrations of development necessitating additional station locations. Further agreements should be negotiated with the Forest Service to provide wildland fire protection to private land, and arrangements should be made for mutual cooperation among volunteer and public fire protection units.

Schools

The only existing school in the Canyon is the Ophir Grade School serving grades 1 - 8. Depending upon the rate of growth in the Canyon, particularly in some areas where greater development may occur, additional educational facilities may be warranted. However, it is a recommendation of this plan that no additional schools be constructed in the Canyon until such time as the increased demand warrants the construction of facilities adequate for a full eight elementary grades.

Proposed land use patterns indicate only the West Fork area as having potential growth necessitating a nearby school. Should such a need arise the school should be constructed in a central location and on a major circulation route. Specific locations and facility designs should be approved by the appropriate local jurisdiction.

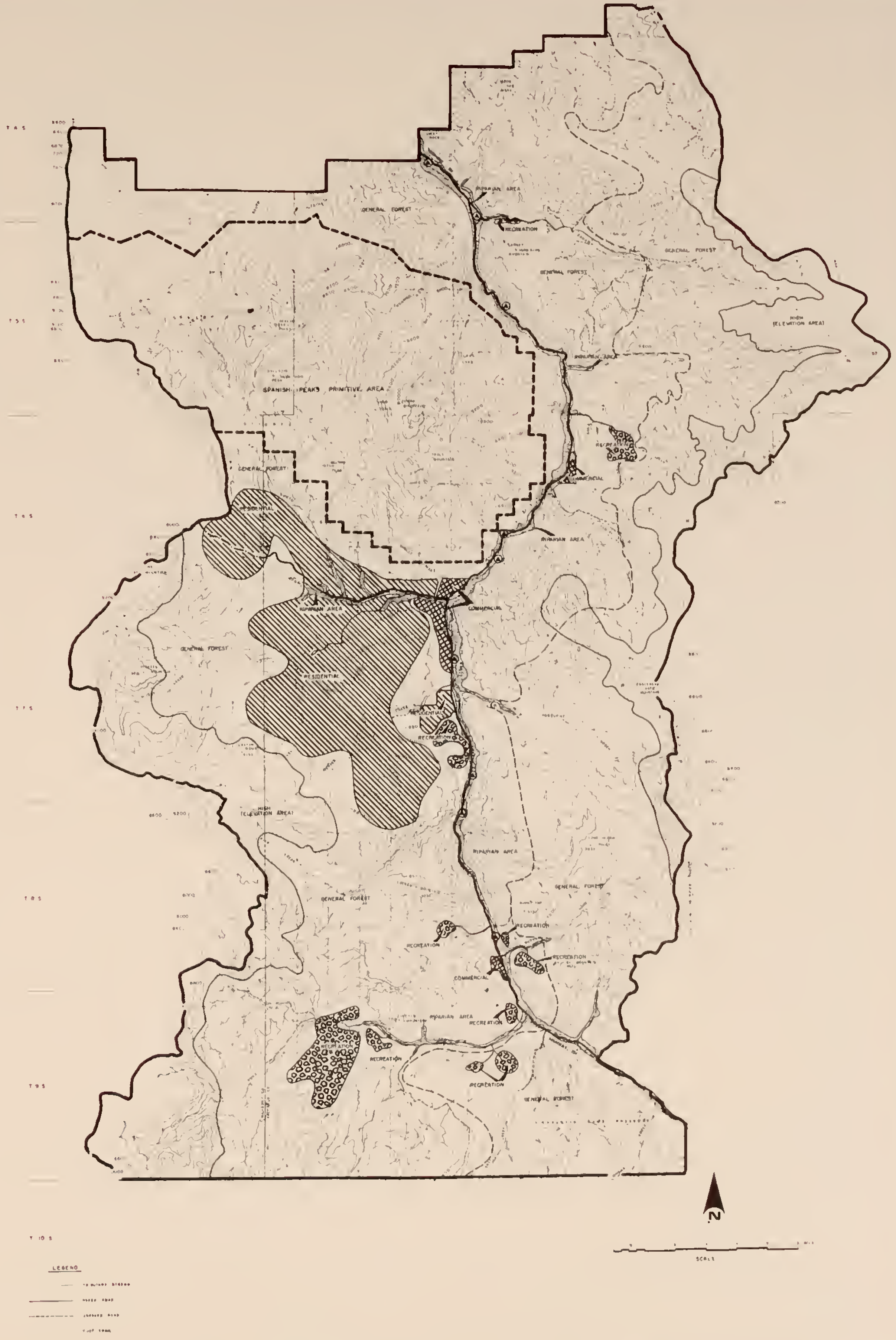
LEGEND

LAND USE ELEMENTS

- ▨ RESIDENTIAL
- ▩ COMMERCIAL
- ☐ GENERAL FOREST
- ⊚ RECREATION
  - COMMERCIAL USE
  - DISPERSED ACTIVITY
- ▤ RIPARIAN AREA
- ┅ SPANISH PEAKS PRIMITIVE AREA
- ☐ HIGH (ELEVATION AREA)

CIRCULATION ELEMENT

- ∿ HIGHWAY 191 AND MAIN ROADS
- ‐·‐ FUTURE HIGHWAY CONNECTION TO MADISON VALLEY
- RECREATIONAL TRAILS
  - ‐ ‐ ‐ SNOWMOBILE TRAIL
  - ⋯ HIKING / EQUESTRIAN TRAILS
- Ⓐ REST AREAS, SCENIC OVERLOOK, AND PICNIC AREAS



GALLATIN CANYON PLANNING STUDY

COMPREHENSIVE PLAN

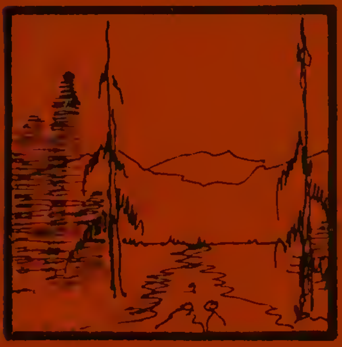
PREPARED FOR
MONTANA STATE DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

THE MURRAY-McCORMICK
ENVIRONMENTAL GROUP
ECOSYSTEMS ANALYSIS PLANNING ARCHITECTURE ENGINEERING

IMPLEMENTATION GUIDELINES

DEVELOPMENT PLANNING AND DESIGN GUIDELINES

DRAFT ZONING ORDINANCES



MANAGEMENT AND MONITORING PROGRAM

DEVELOPMENT PLANNING AND DESIGN GUIDELINES

> "Environmental excellence occurs when all forms of life exist in the greatest possible natural harmony with all other forms and with the natural environment in a manner in which none disturbs or detracts unnecessarily from another."[1]

The recommended Development Planning and Design Guidelines along which future development in Gallatin Canyon should be planned are presented in this section. These recommendations will provide a means to preserve the unique scenic and recreational aspects of the area, while allowing development which is compatible to the public and private interests concerned.

The Development Planning and Design Guidelines present a set of environmental criteria to serve as a guide for effectuating the planning considerations developed in this study. These guidelines strive toward excellence in each element of the plan. They are intended to represent the best possible solutions to environmental problems that can then be used as a standard against which all planning and coordination decisions should be measured.

The suggested standards and sketches on the following pages are presented to illustrate the general approach to land development and construction for Gallatin Canyon. These guidelines are not intended to impose strict limitations on site and architectural design, but to illustrate possible solutions toward protecting the basic natural resources of Gallatin Canyon.

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[1] "Willamette Valley Program Design," Lyle Stewart.

NATURAL AREAS

Areas of the Canyon which are of unique scenic value or which contain areas of exceptionally sensitive vegetation, soils, or geology should be preserved in their natural condition virtually free of development.

Dispersed recreational activities such as snow play areas, trail systems, or hunting would be appropriate for the remaining open space.

The development and use of these areas by public and private interests should follow the Comprehensive Land Use Plan and Development Guidelines, suggested below, in conjunction with a Multiple Land Use Management Guide.

Riparian Areas

Riparian areas should be maintained free from development as they are sensitive to disturbances - especially erosion and pollution. These in turn affect the fish habitats and spawning areas.

To preserve the natural scenic values of the waterways and to protect the water quality, no waste disposal lines should be permitted within 100 feet of these areas. Overhead utility transmission lines should be screened from general view.

To maintain the resource value and quality of the waterways, all streams should be protected through water quality monitoring and management programs.

Riparian areas are wildlife migration corridors and browse areas; therefore, access to streams should not be blocked by construction, roadways, or excessive human activity; nor should excessive clearing be allowed.

Edges of waterways and reservoirs should be maintained in natural landscape treatment, rather than introducing materials foreign to the general area.

Primitive Areas

All activities within the Primitive Areas should be designed to implement the multiple use management concept for primitive areas as stated in the Forest Service Multiple Land Use Management Guide.* (A new management guide is being prepared for the Spanish Peaks Primitive Area during the spring of 1972.)

Although development within primitive areas for the convenience of users is not considered essential, some facilities are necessary to protect the environment. They might include the following:

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*Multiple Use Management Guide. (1967).

- Campsites to limit the extent of improper campfire practices.
- Campsite maintenance facilities.
- Sanitary facilities and trash containers.
- Hitching posts.
- Firewood supplies for heavily used camping areas.

Sites of special scenic, historical, geological, and archeologic value should be identified and protected.

Unstable Areas

Development in areas of unstable soil and geologic conditions should not be allowed due to the possible danger of landslide and slumps and the destruction of sensitive wildlife areas. Precautions should be taken to stabilize soils and other dangerous conditons, where appropriate. Transmission utility line locations should be restricted from these areas. Consideration should be given to replanting bare slopes and areas of high erosion with species natural to the area.

High (Elevation) Areas

Due to the sensitive vegetative cover and thin soils in these areas, roads should be prohibited. Trails should be located and designed so as to cause the least amount of ground disturbance.

Provide access for hunters in their pursuit of game and for other recreationists to points of interest.

The value of standing trees for watershed, wildlife, scenic or other recreational purposes should be considered in the choice of timber cutting measures for controlling fire, insects and disease.

Any lumbering practices should follow the guidelines as set in the Forest Management section, with maintenance of the scenic quality of the area as the primary objective.

GENERAL FOREST AREA

Development within this area should be designed to implement the criteria similar to that suggested in the Multiple Use Management Guide of the U.S. Forest Service.

Development within the General Forest Areas should include the following:

A. Areas of exceptional scenic, historic, or geologic value should be identified and protected;

B. Campsites, recreation areas, and residences should be landscaped so as to decrease their visual impact on the area;

C. All utility and transmission lines should be placed underground wherever feasible. If not, they should be screened or painted so as not to be a visual blight on the area; and

D. Development should be located away from elk and other wildlife migration corridors, as they are necessary to the total wildlife habitat.

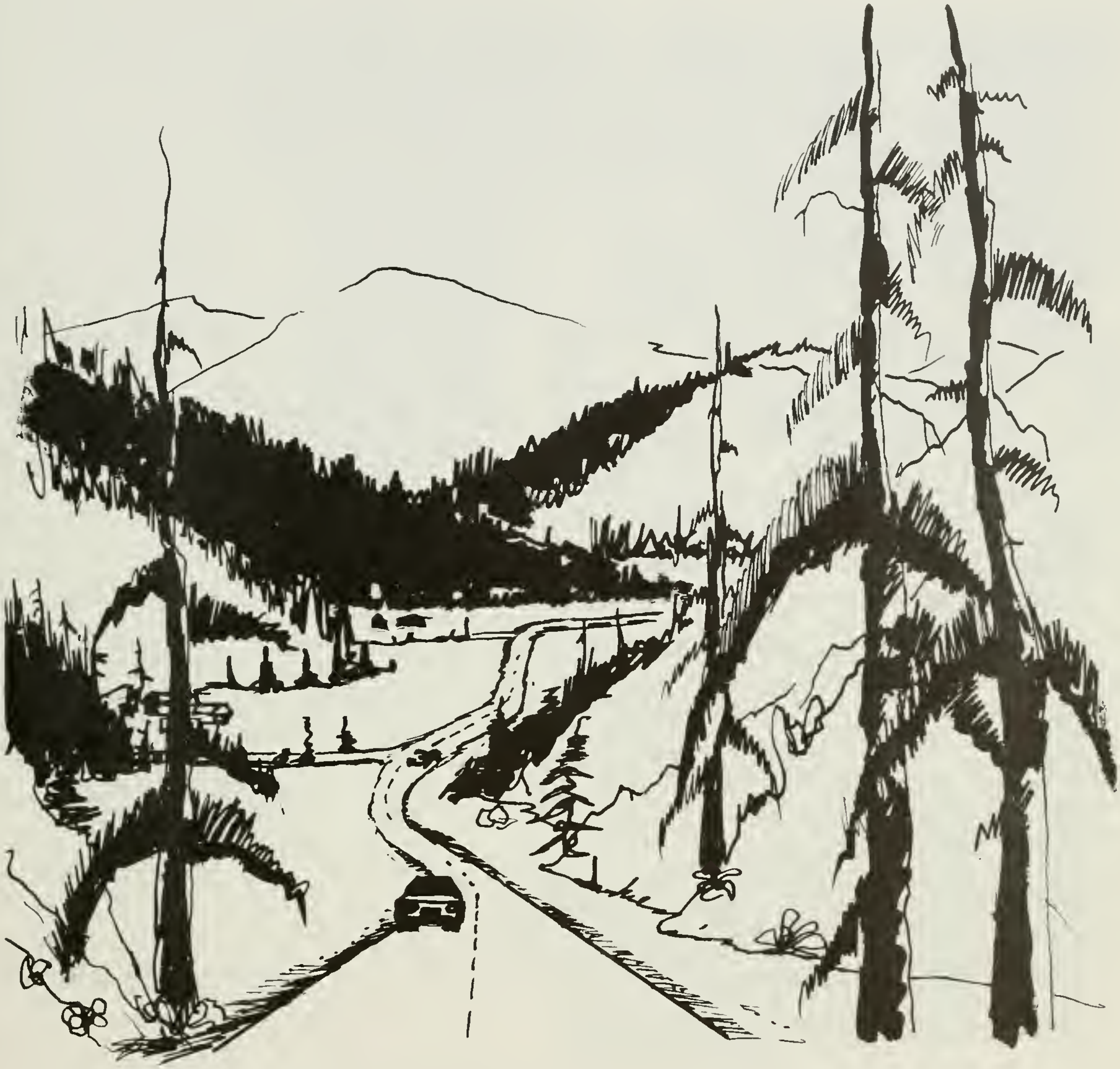
RESIDENTIAL AREAS

Future residential development within the Canyon should be in clusters as opposed to typical subdivision patterns. The intent is to keep the impact of the development on the natural landscape to a minimum and to create the least possible visual impact. Cluster housing and development would help concentrate man's activities resulting in less disruption of the natural landscape and wildlife habitat.

Non-clustered development should not be allowed to continue especially along major highways. All development should be adequately screened from major roads and highways to protect the scenic visual qualities of the Canyon.

Any proposed development should adhere in its purpose and design to the Comprehensive Plan or to the various elements included or to the area plan of the particular location in which the proposed development is to be constructed.

Clustered Development. Design criteria for such developments should include consideration of the following guidelines:



FUTURE RESIDENTIAL DEVELOPMENT IN GALLATIN CANYON SHOULD ADHERE TO THE CLUSTER CONCEPT AS OPPOSED TO TYPICAL SUBDIVISION PATTERNS. THE INTENT IS TO KEEP THE VISUAL IMPACT OF DEVELOPMENT ON THE NATURAL LANDSCAPE TO A MINIMUM.

Figure I-19

A. Separate automobile, pedestrian, and equestrian travel on the site;

B. Hide building clusters from view of motorists by:

   1) Natural vegetation,

   2) Landscaping,

   3) Terrain, or

   4) A setback of at least 100 feet from nearby roads; and

C. Encourage use of different types of living units within concentrated areas.

General Criteria

Higher density developments are to be considered as particularly suitable to areas where there is direct access or proximity to community facilities and circulation routes, and/or commercial services.

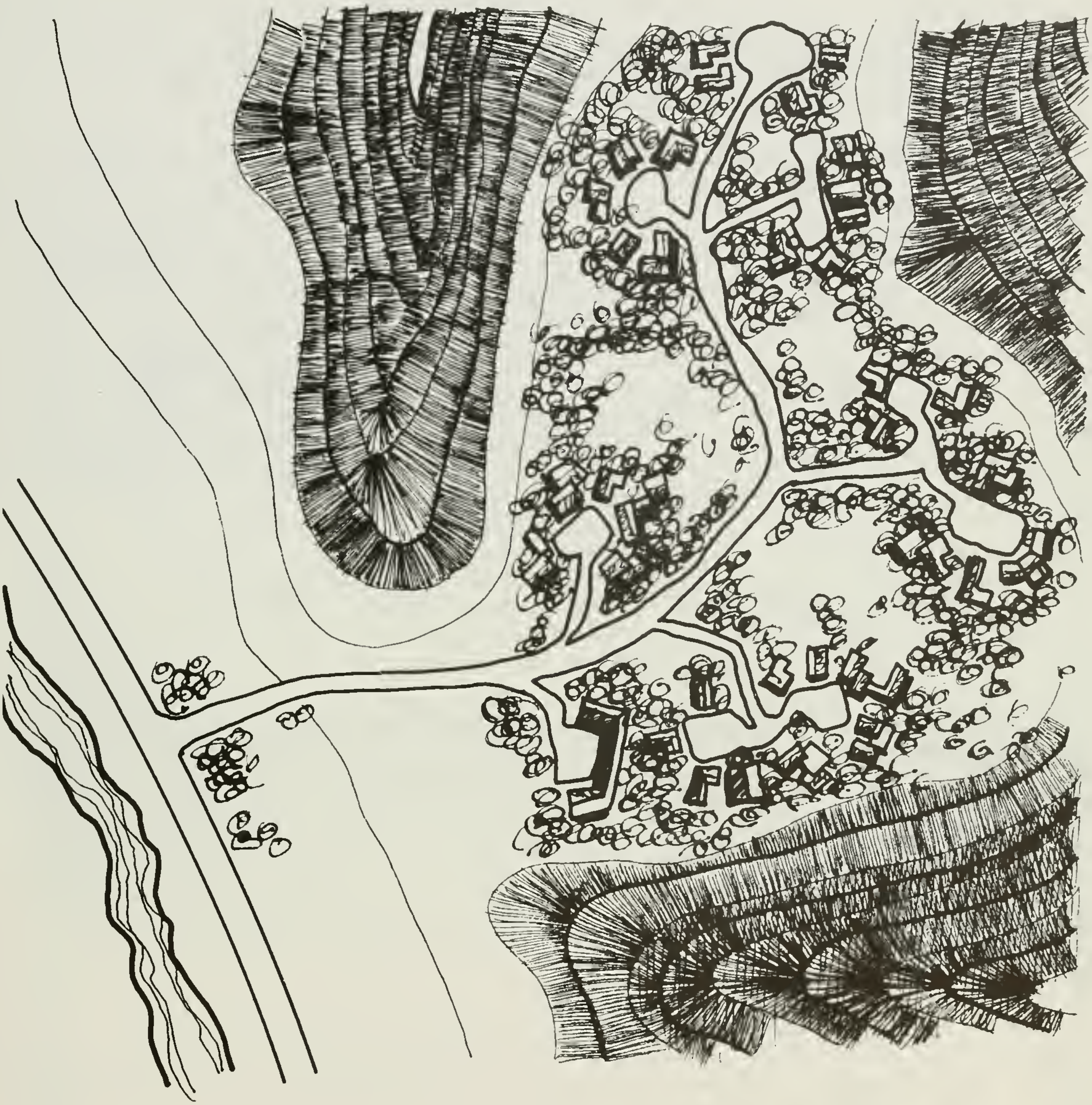
Lower density developments should utilize areas where there are steep slopes, canyons or mountainous terrain, and where there is restricted accessibility to service facilities.

Design criteria for both clustered and non-clustered development should include the following:

A. Plan development features to coincide with the natural environmental features, and designed in such a way as to diminish the visual impact of the development;

B. Incorporate natural features (such as rock outcroppings, ridges, hillocks) as much as possible into the design of any development;

C. Retain and manage open space as a valuable resource;



DENSE CLUSTERED DEVELOPMENT IS TO BE CONSIDERED AS PARTICULARLY SUITABLE FOR DEVELOPMENT IN THE CANYON. BUILDING CLUSTERS SHOULD BE LOCATED AWAY FROM OR ON THE EDGE OF OPEN MEADOWS, AND IN SUFFICIENT TREE COVER FOR SCREENING PURPOSES. SUFFICIENT SETBACK SHOULD BE MAINTAINED FROM MAIN ROADS SO AS NOT TO INTERFERE WITH THE VISUAL SCENIC QUALITIES OFFERED BY THE LANDSCAPE.

Figure I-20

D. Utilize sloping topography wherever possible, and vegetation to screen or soften the visual impact of building construction;

E. Minimize the harmful effects of water runoff, including soil erosion, by the use of landscaping and/or drainage systems. (Effectiveness of these systems should be judged by the extent to which they minimize their effects on surrounding land. The transfer of runoff problems to other properties should not be considered an appropriate solution.)

F. Discourage extensive grade and fill operations that substantially alter the topography of a site;

G. Limit access to major roads from adjoining property (numerous curb-cuts along the highway should be avoided by orientation of dwelling units to frontage roads or single accesses serving several properties);

H. Fringe parking areas or other large paved areas with plant materials or earth landforms to diminish the visual impact of such development. (All possible vehicular hazards to pedestrians should be eliminated);

I. Use natural or compatible building materials throughout the project in various textures and compliment them by the use of earth tone stains in a manner to create a weathered but warm appearance throughout;

J. Use plant materials found only in the natural landscape;

K. Incorporate setback lines for buildings or structures along the main road (exact distances to be determined from the use area and frontage access);

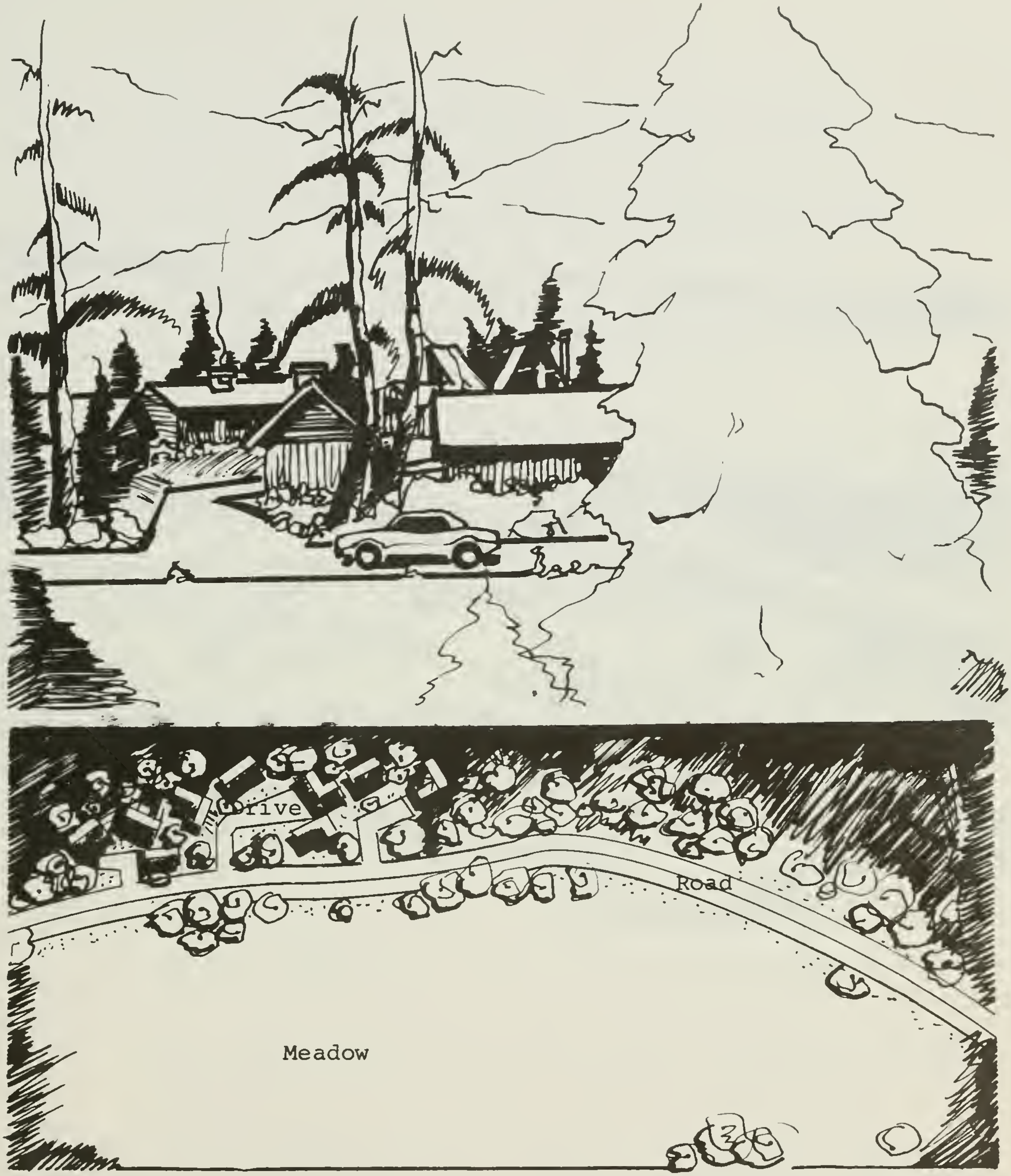
L. Use protective erosion control measures for buildings, roads, parking lots, and recreational facilities;

M. Employ screening methods or underground installation for all new utility services (wherever possible also do the same with existing lines);

N. Protect sound, healthy trees and ground cover vegetation;

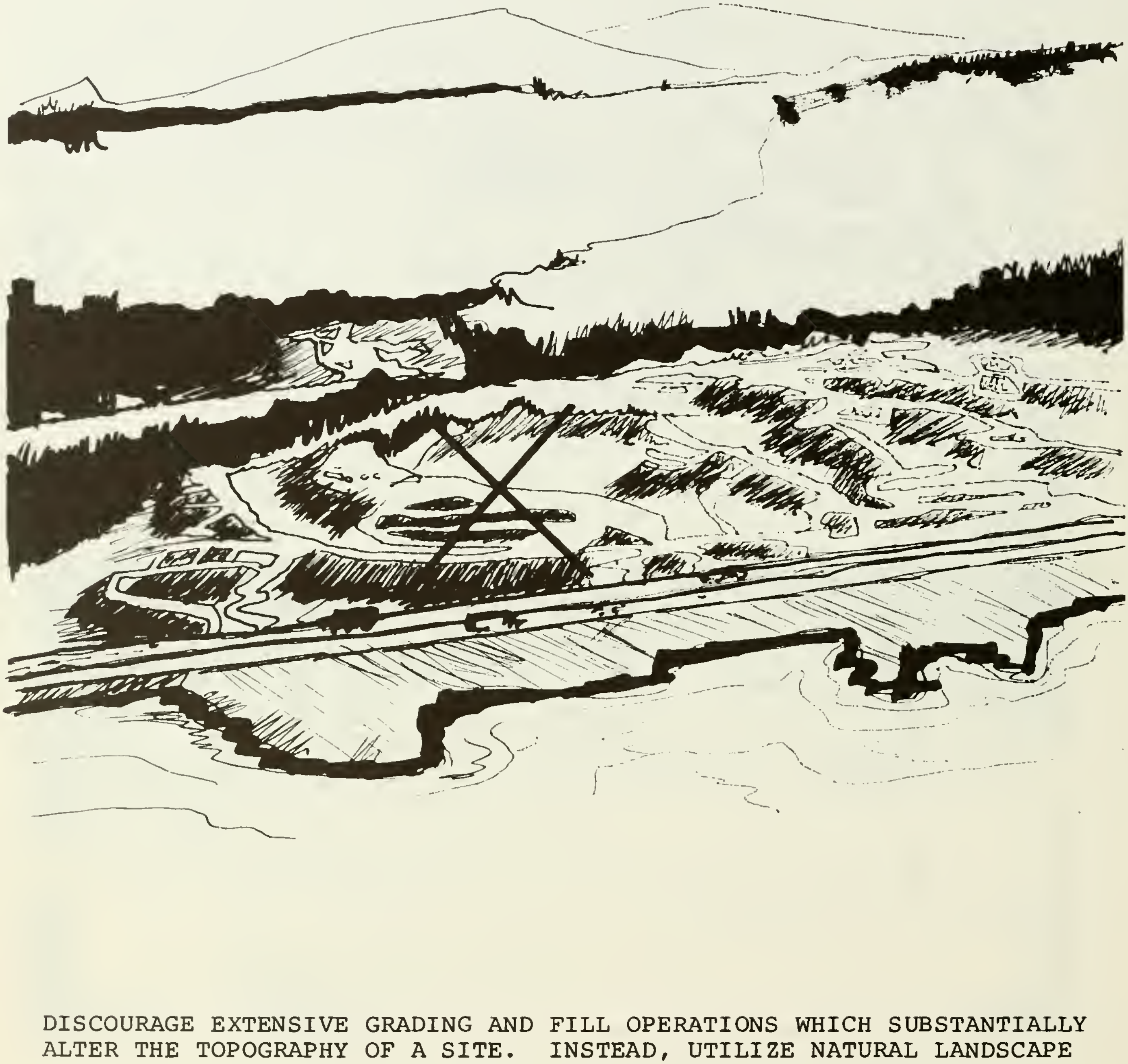
O. Provide for non-intervention with, and the retention of, natural drainage flows;

P. Develop interest and variety in architectural silhouettes;



WHERE BUILDING CLUSTERS ARE LOCATED ADJACENT TO MAIN ROADS, THEY SHOULD BE GENERALLY SCREENED BY LANDSCAPING AND EARTH-FORMS. SEVERAL BUILDINGS SHOULD UTILIZE ONE DIRECT ACCESS TO MAIN ROADS TO ELIMINATE NUMEROUS CURB CUTS AND TO CREATE LESS TRAFFIC INTERFERENCE.

Figure I-21



DISCOURAGE EXTENSIVE GRADING AND FILL OPERATIONS WHICH SUBSTANTIALLY ALTER THE TOPOGRAPHY OF A SITE. INSTEAD, UTILIZE NATURAL LANDSCAPE FEATURES SUCH AS SLOPING GROUND, ROCK OUTCROPPINGS, AND VEGETATION AS MUCH AS POSSIBLE INTO THE SITE DESIGN OF ANY DEVELOPMENT. PROPER SITE TREATMENT WILL MINIMIZE THE HARMFUL EFFECTS OF WATER RUNOFF AND SOIL EROSION.

Figure I-22

Q. Orient buildings toward views wherever possible;

R. Provide for fire suppression and control methods;

S. Prevent incompatible use of land and disruptive non-residential traffic from intruding upon residential areas;

T. Encourage collective private driveways where their utilization will result in better building sites and lesser amounts of land coverage than would result if a public road were required; and

U. Do not encourage future mobile home development within the Canyon, and where they are presently located, screen completely from adjacent land uses.

COMMERCIAL AREAS

Commercial development should be restricted to nodes along Highway 191 to prevent unsightly linear development of service areas on the major roads.

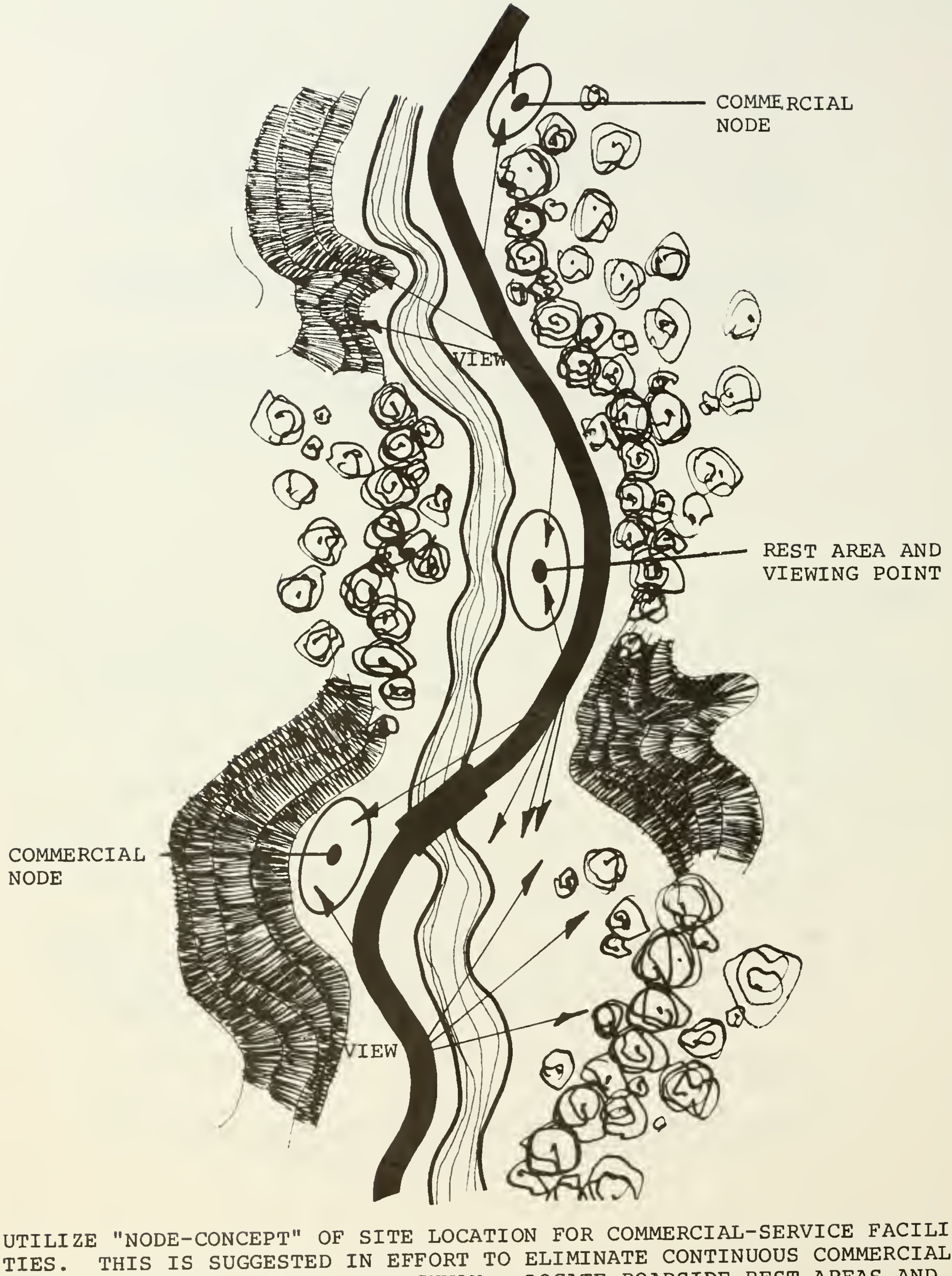
Basically the same criteria as proposed for residential cluster developments will apply to commercial facilities. They are:

A. Select architectural styles and building materials and colors compatible with the natural environment;

B. Allow the architectural theme to be the primary identifying factor (architectural treatment is important to the appearance of the project or building, and a unifying theme should be maintained throughout the project);

C. Develop three-dimensional visual interest for identification;

D. Design building clusters to diminish the visual impact of such development on the major roadways;



UTILIZE "NODE-CONCEPT" OF SITE LOCATION FOR COMMERCIAL-SERVICE FACILITIES. THIS IS SUGGESTED IN EFFORT TO ELIMINATE CONTINUOUS COMMERCIAL-STRIP DEVELOPMENT ALONG THE HIGHWAY. LOCATE ROADSIDE REST AREAS AND VIEWING POINTS AT APPROPRIATE SPOTS ALONG THE HIGHWAY.

Figure I-23

E. Adhere to setback lines for buildings on structures along Highway 191, to be determined from the use area and frontage access;

F. Select a site large enough to provide ample parking;

G. Fringe parking areas or other large paved areas with landscaping to diminish the visual impact of such development;

H. Retain as much of the natural environment as possible by leaving native ground cover in buffer zones; designing cuts and fill to reflect the natural topography; and avoiding excessive site preparation;

I. Limit direct access points to Highway 191 based on safety to travellers on the road;

J. Limit interference with natural drainage flows;

K. Do not clutter development - provide ample room for expansion;

L. Provide screening and light shielding for adjacent residential property;

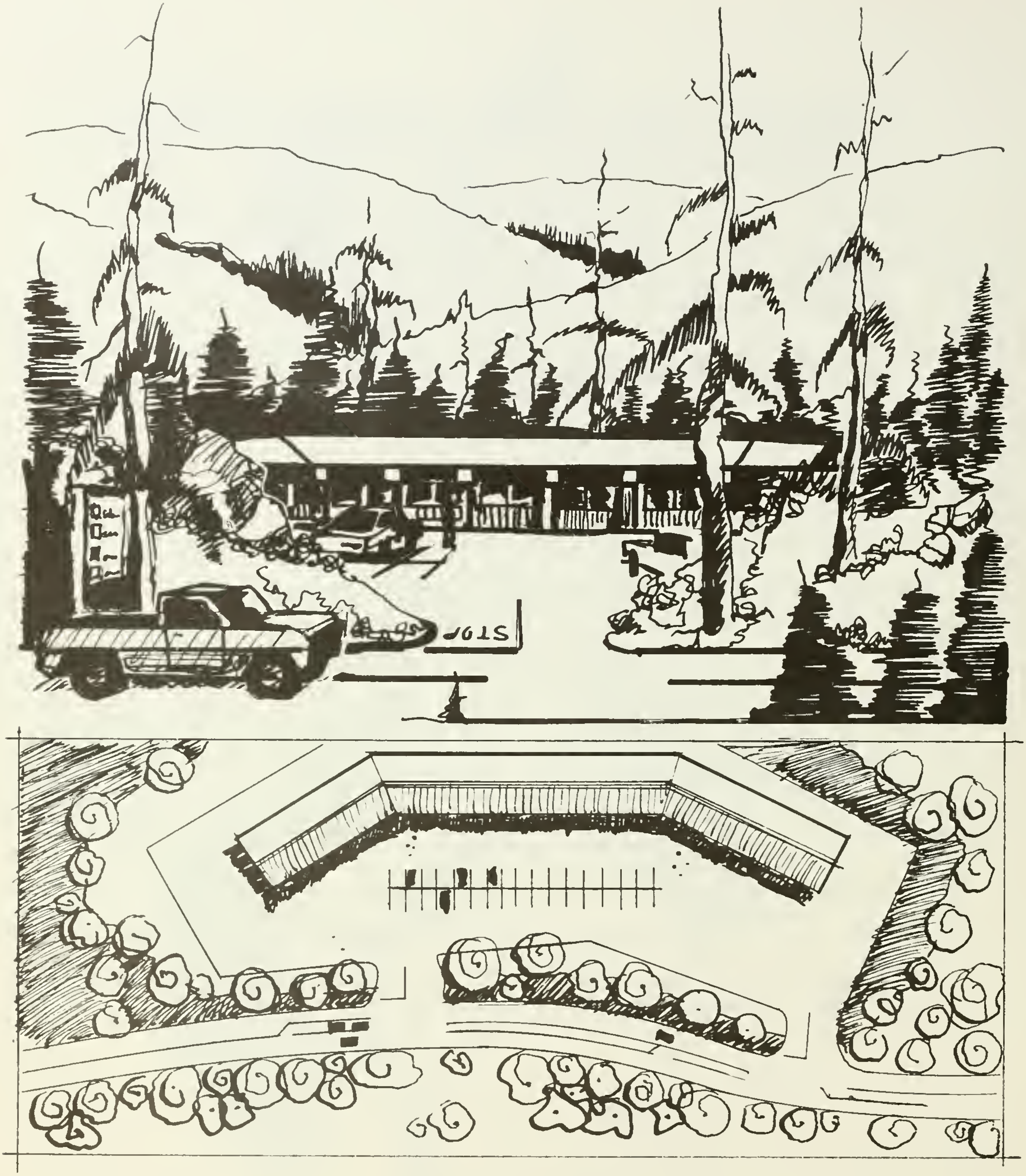
M. Provide for landscaping and revegetation due to construction activities;

N. Use signing restrictions (see special section regarding Signing Control);

O. Design the complex to be attractive from all directions;

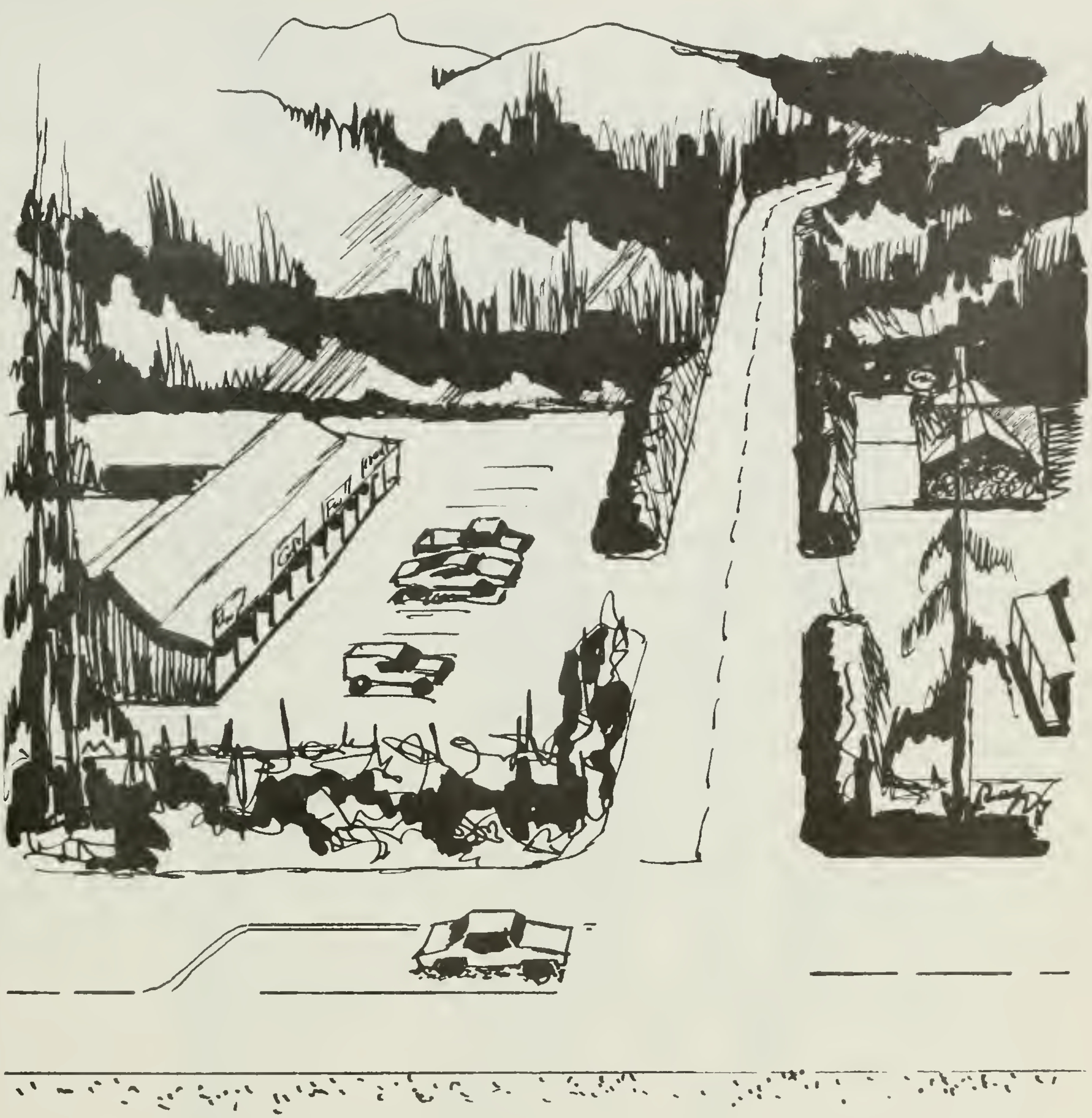
P. Provide underground power and telephone services; and

Q. Make provisions for erosion control, fire protection, and safe sewer and water operation.



COMMERCIAL DEVELOPMENT SHOULD BE DESIGNED IN AN ARCHITECTURAL STYLE COMPATIBLE WITH THE NATURAL ENVIRONMENT. BUILDING CLUSTERS SHOULD BE GENERALLY SCREENED FROM THE ROADWAY BY RETAINING AS MUCH OF THE NATURAL LANDSCAPE AS POSSIBLE. ONLY VEGETATION NATIVE TO THE AREA SHOULD BE USED IN LANDSCAPE TREATMENT. SIGNING SHOULD ADHERE TO THE SUGGESTED GUIDELINES AND SHOULD NOT BE DOMINANT IN APPEARANCE.

Figure I-24



COMMERCIAL-SERVICE DEVELOPMENTS SHOULD BE LOCATED ON SITES LARGE ENOUGH TO PROVIDE FOR RELATED FACILITIES AND EXPANSION. DIRECT ACCESS TO THE HIGHWAY SHOULD BE HELD TO A MINIMUM UTILIZING SIDE ROADS WHEREVER POSSIBLE. THE COMPLEX SHOULD BE DESIGNED TO BE ATTRACTIVE FROM ALL DIRECTIONS, AND ADHERING TO ALL THE SUGGESTED DEVELOPMENT GUIDELINES.

Figure I-25

RECREATIONAL DEVELOPMENT

Locate public recreation facilities at a sufficient distance from "streams, trails, and other natural attractions to allow appropriate use without unacceptable depreciation of the focal point of public interest."[1] Before any actual facility construction, analyze local site conditions in relation to potential environmental impact.

Campgrounds

Campground units should be spaced to preserve the natural state of the area and to provide a "camping out" experience. They should be on fairly flat terrain but surrounded by more variable terrain. All campgrounds should contain a potable water supply and sanitary facilities as a basic minimum requirement.

Plans for campgrounds should include:

A. Develop suitable methods for sanitary and solid waste disposal, in accordance with County Forest Service standards;

B. Employ fire breaks and fire safety planning (along with stove design and campfire regulations are to be in keeping with the U.S. Forest Service requirements);

C. Use dust control measures;

D. Use erosion control and replanting where possible in areas where the natural vegetation has been removed;

E. Provide sources of firewood to protect the local timber and vegetation;

F. Use simple log barriers at the end of parking pads to prevent the encroachment of vehicles;

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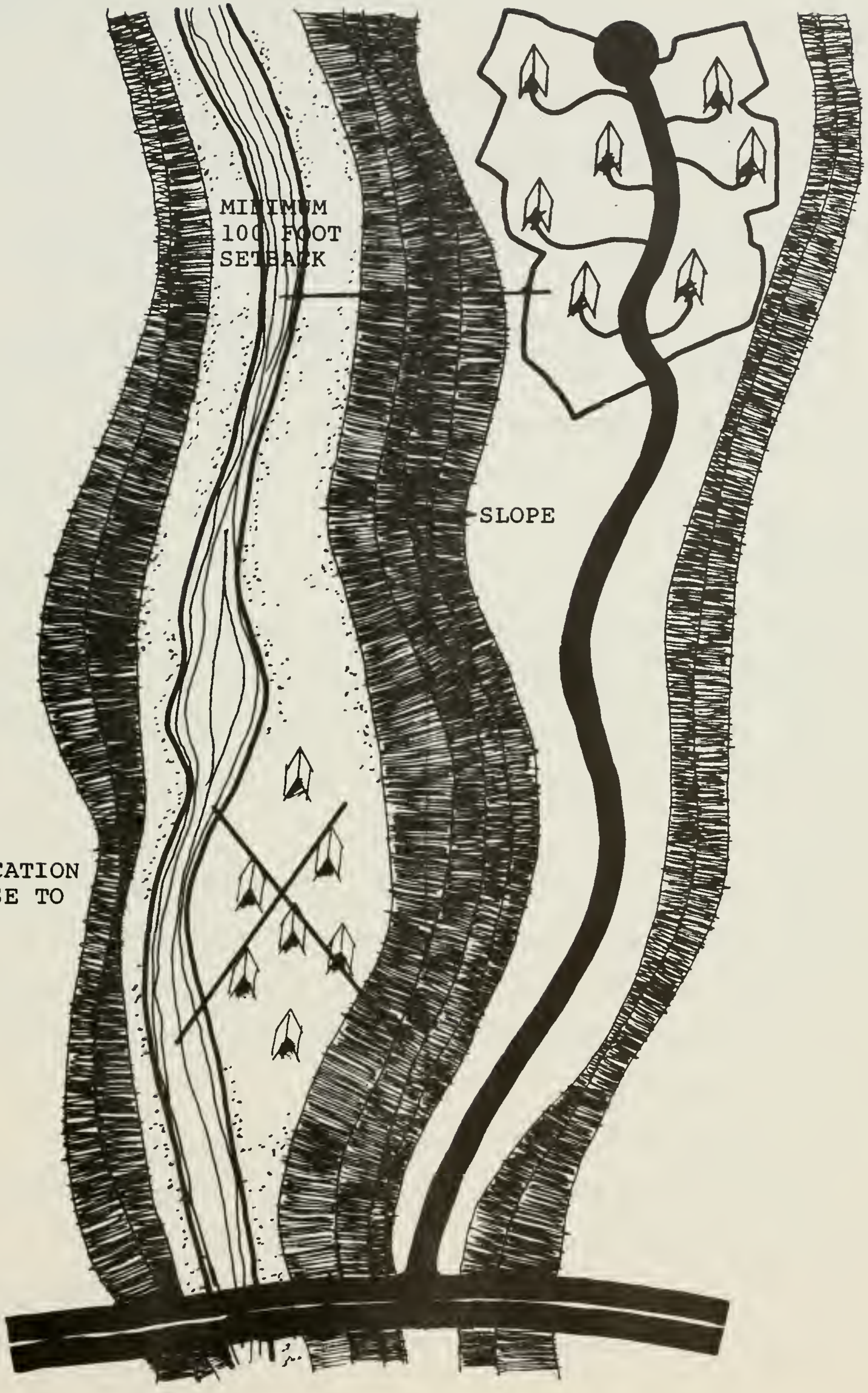
[1] Forest Service Multiple Use Management Guide. (1967.)

CAMPGROUNDS



CAMPGROUND UNITS SHOULD BE SPACED TO PRESERVE THE "NATURAL-STATE" OF THE SITE, AND YET BE CLOSE ENOUGH FOR THE NECESSARY RELATED SERVICE AND SANITARY FACILITIES.

Figure I-26

G. Provide firepits at each campsite;

H. All campground areas should be clear of excess brush, snags, and hazardous trees;

I. Ensure that campgrounds constructed in the wildlife corridor should not be utilized until spring each year;

J. Provide a comprehensive fire plan, post pertinent regulations, and enforce them strictly by the management staff; and

K. Provide maintenance and supervision.

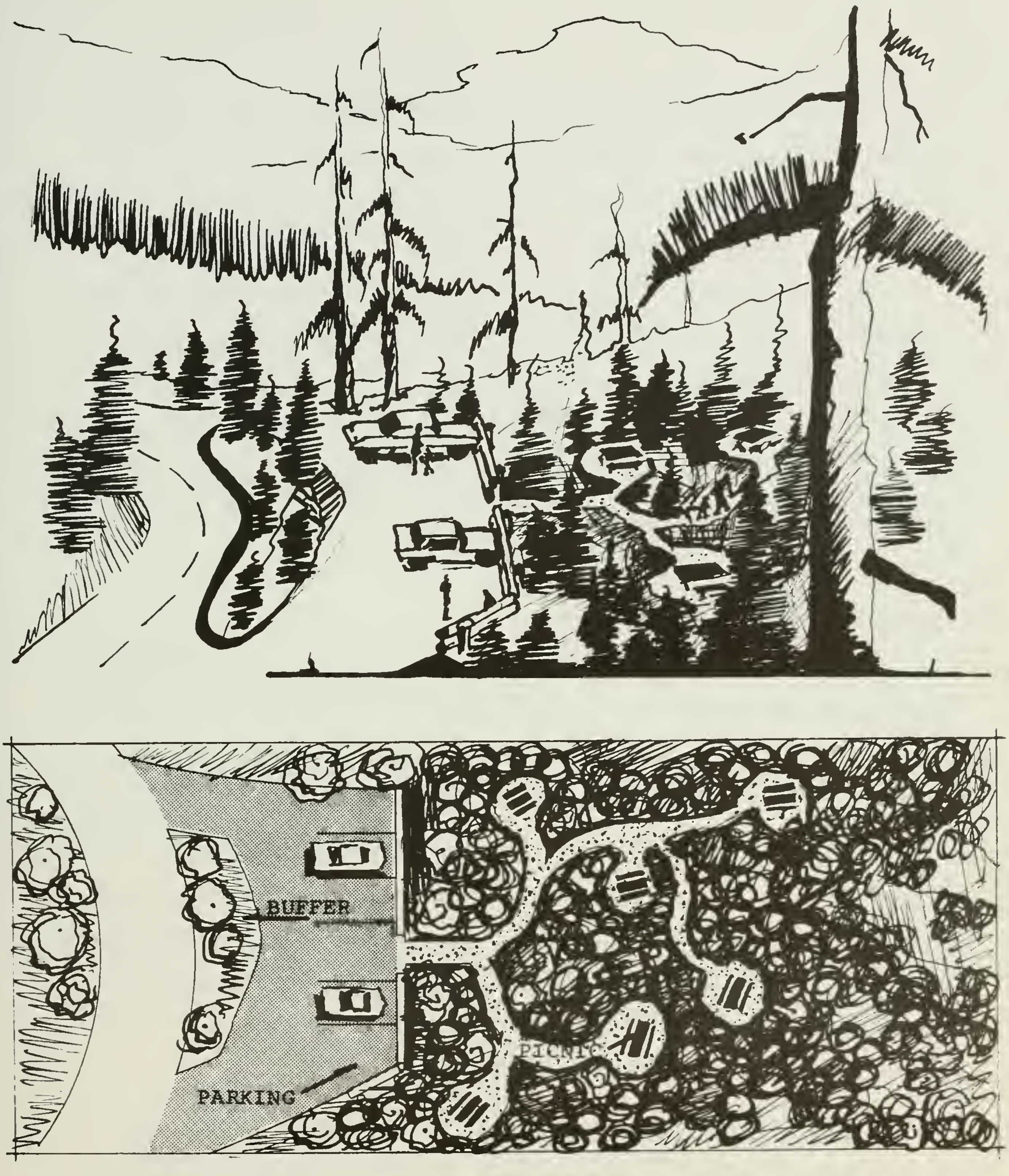
Picnic Areas

Picnic areas should be day-use areas located in areas of similar compatible land use such as camp and resort areas, rest areas, and scenic vista points. The minimum required facilities should be tables, fire pits, drinking water, and sanitary facilities.

A picnic area may consist of one facility or many, but the same principles apply. There should be advanced signing and ease of turnoff and parking. Physical and psychological separation from the main roadway by earth mounds and planting of native materials is suggested.

The pavement for approach exits and parking should be natural appearing, asphalt, or loose pebbles. Adequate parking in area must be provided.

The areas should be located near distinctive landscape features that provide opportunities for choice of picnic table loca-



ROADSIDE REST AREAS SHOULD BE LOCATED ALONG HIGHWAY 191 AT APPROPRIATE LOCATIONS. FACILITIES FOR THE REST AREAS SHOULD BE ARCHITECTURALLY AND ENVIRONMENTALLY HARMONIOUS WITH THE REGIONAL LANDSCAPE.

tions. Whenever possible advantage should be taken of natural shade. Fire control around picnic tables should be designed.

Motel and Tourist Facilities

Motels and tourist facilities should be combined with other commercial uses in the commercial service nodes, near summer home areas, and by public campgrounds. They should have good vehicle access, together with adequate parking space and landscaping. Where feasible, they should be combined with other recreational facilities such as tennis courts and riding stables.

Guest Ranches

Guest ranches should conform to the design and development guidelines suggested for residential development. They should be located so as to minimize any potential conflict with adjacent and surrounding land uses. Guest facilities should be designed solely for resort-type use --- never to include individual dwelling facilities, except as required for management. Adequate access, parking, and related recreational facilities should be provided. All guest ranch development should be designed in the cluster concept.

Snow Play and Recreation Areas

The following list summarizes the recommended guidelines for snow play areas:

A. Locate snowmobile runs away from populated areas;

B. Provide adequate off-road parking for autos and trailers;

C. Provide sanitary facilities for participants and adhere to sanitary regulations;

D. Follow erosion control measures;

E. Provide maintenance and supervision;

F. Avoid placing snow play areas on southerly aspects and conversely place as many winter camping spaces on southerly slopes as possible; and

G. Select ski trails to minimize the clearing of vegetation.

CIRCULATION

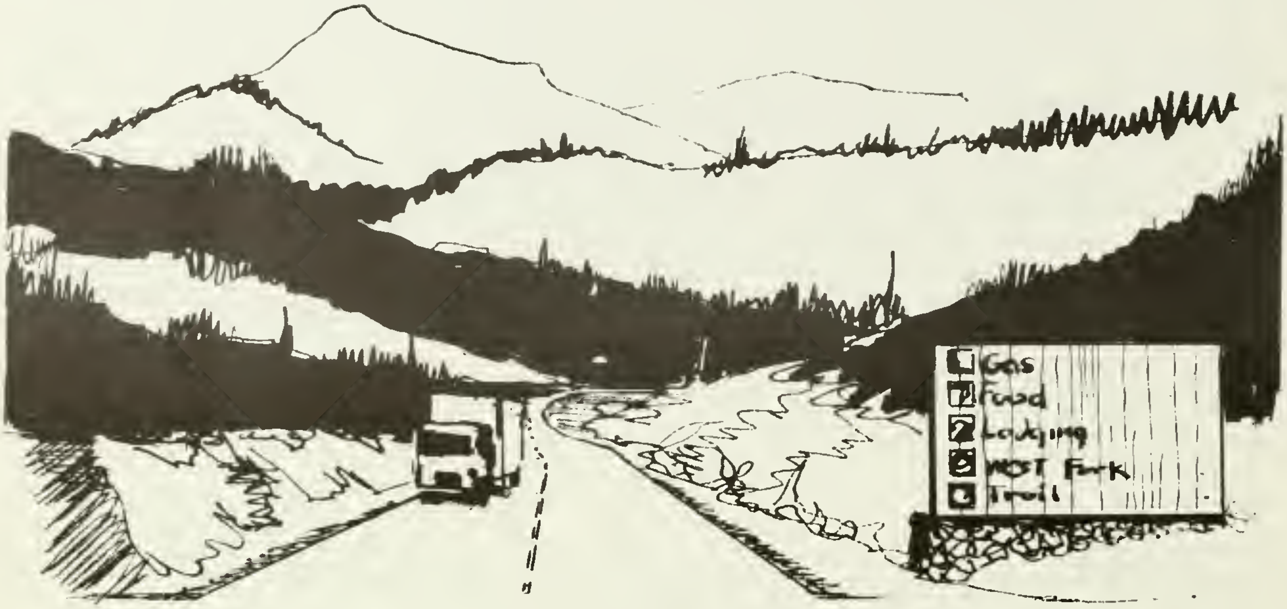
General Highway and Road Development

The following list summarizes the areas of greatest concern for the proper development and protection of the surrounding environment:

Highways:

A. Provide a right-of-way of sufficient size to contain:

  - Two paved travel lanes (highways should not exceed two travel lanes);
  - Shoulders;
  - Safety and snow storage strips;
  - Pathways for safe pedestrian-equestrian movements, when necessary, and with ties to external trail systems; and



HIGHWAY IMPROVEMENTS SHOULD BE DESIGNED TO ACCOMMODATE THE SUGGESTED DEVELOPMENT GUIDELINES. UTILITY LINES SHOULD BE PLACED UNDERGROUND OR LOCATED SO AS TO HAVE A MINIMAL IMPACT UPON THE VISUAL FIELD. A STANDARDIZED SYSTEM OF ROAD SIGNS SHOULD BE UTILIZED, AND THEY SHOULD BE OF A CHARACTER UNIQUE TO THE REGION.

Figure I-28

- Screening and landscape treatment of unsightly roadway construction scars.

B. Use native vegetation to cover and screen, and use other devices to hide the scars of roadway cuts;

C. Revegetate old borrow pits and haul roads to eliminate any scars on the landscape;

D. Locate roadside rest areas, wayside picnic areas, and scenic viewpoints where the topography is compatible for the use of motorists.

E. Ensure that all architectural and engineering elements relate pleasantly and are in harmony in material, color, and form to the local environment;

F. Hold intersections with side streets and major thoroughfares to a minimum (where they must intersect, cross and left-turn movements should be limited by median and left-turn lanes. Roadside rest areas, wayside picnic areas, and scenic overlooks should be located at intervals where topography is compatible. Criteria for selection of these areas will involve topography, character of view, possible multiple uses to reduce numbers and costs and safety); and

G. Limit access to the street from adjoining properties (numerous curb cuts along the street should be avoided by utilizing single accesses serving several properties).

Secondary Roads and General Construction

A. Locate roads to avoid traversing open meadow areas;

B. Include the consideration of the need for elk and deer movement on slopes in road location and design and do not create travel barriers for big game animals;

C. Require stringent clearing specifications compatible with the aesthetic values of the landscape;

D. Minimize cut and fill slopes when feasible and utilize one-way roads to eliminate unnecessary road widths;

E. Utilize previous road gradings when they can be effectively incorporated into the over-all design and they do not exceed excessive gradients;

F. Provide rock bases and adequate cross drainage on seasonal roads;

G. Treat seasonal, non-surfaced roads with a non-toxic or low-toxic chemical for dust control;

H. Provide at least a 1-1/2 lane road standard on main and alternate fire access roads (all fire access roads should not be open to the general public and should have appropriate signs);

I. Do grading or earth moving operations with a minimum of disturbance to the natural ground which might result in unnatural forms; and

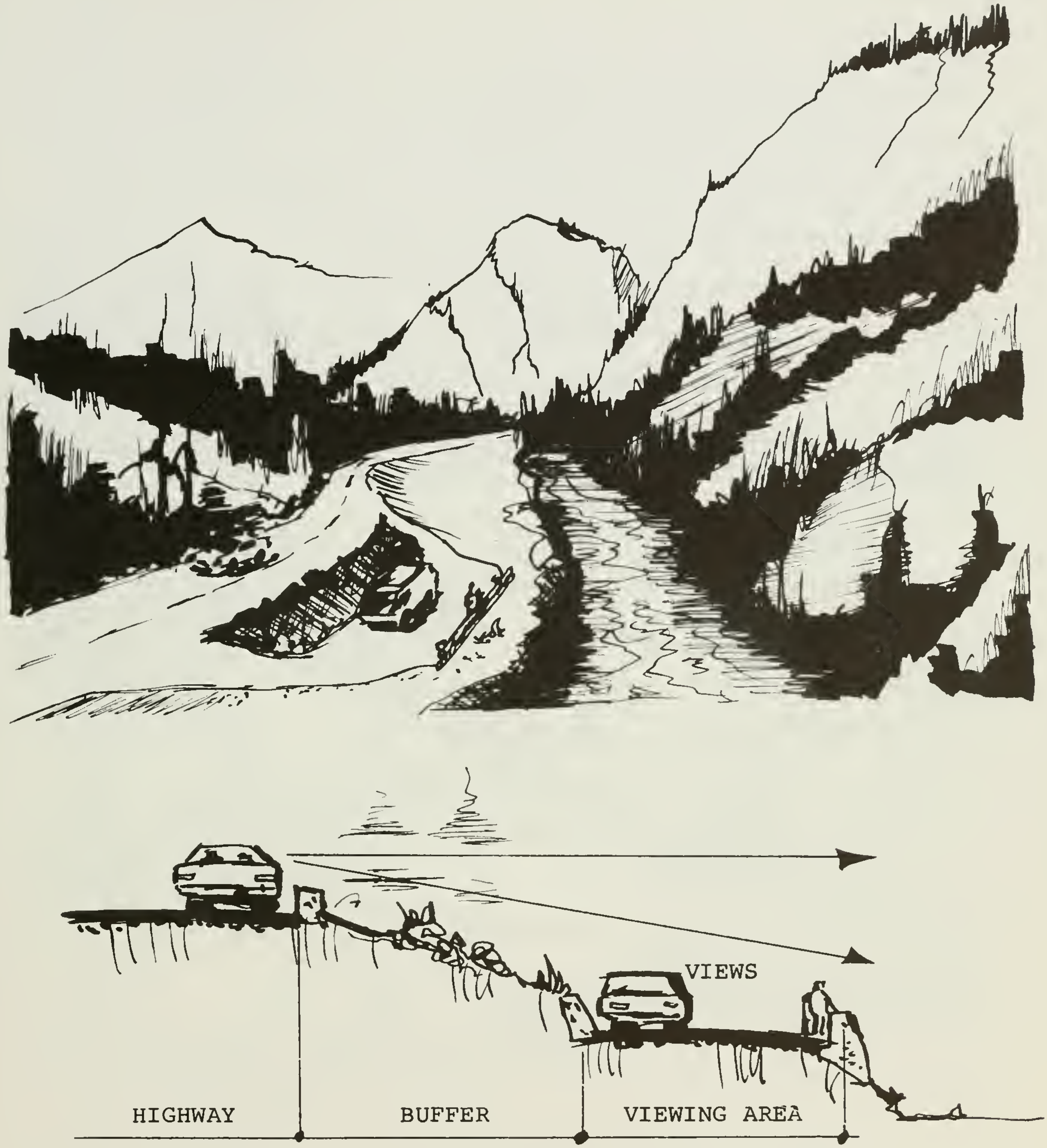
J. Protect residential areas from unnecessary vehicular noice disturbance and air pollution by providing sufficient right-of-way for protective screening.

Rest Stops

Facilities for rest area should be architecturally and environmentally harmonious with regional scenic landscape. Traditional solutions for structures should be respected. Wood siding, stone foundations, and roofing could all be interpreted within modern physical requirements without resorting to contorted image design.

Scenic Overlooks

Scenic overlooks should be located throughout the Canyon wherever site conditions suggest their location. Convenient parking for cars within the view areas should be provided, including



FREQUENT SCENIC OVERLOOKS SHOULD BE PROVIDED ALONG HEAVILY TRAVELLED ROADS. THEY SHOULD BE CONSTRUCTED WHEREVER PARTICULAR SITE CONDITIONS SUGGEST THEIR LOCATION. ENTRANCE AND EXIT POINTS SHOULD BE CLEARLY MARKED, AND CONSTRUCTED SO AS NOT TO INTERFERE WITH NORMAL HIGHWAY MOVEMENT.

Figure I-29

separation between in-car viewing and out-of-car viewing. Views of the parking area from the roadway should be minimized. Lowering of the viewing area below the roadway traffic lanes allows for moving motorists to view over the parking area. The cars would be concealed below a low wall not interrupting the view beyond the parking lot. Lowering of viewing area also cuts down filling and possible erosion problems on sloping sites. Properly located distinctive signing should give adequate advance notice of ingress points.

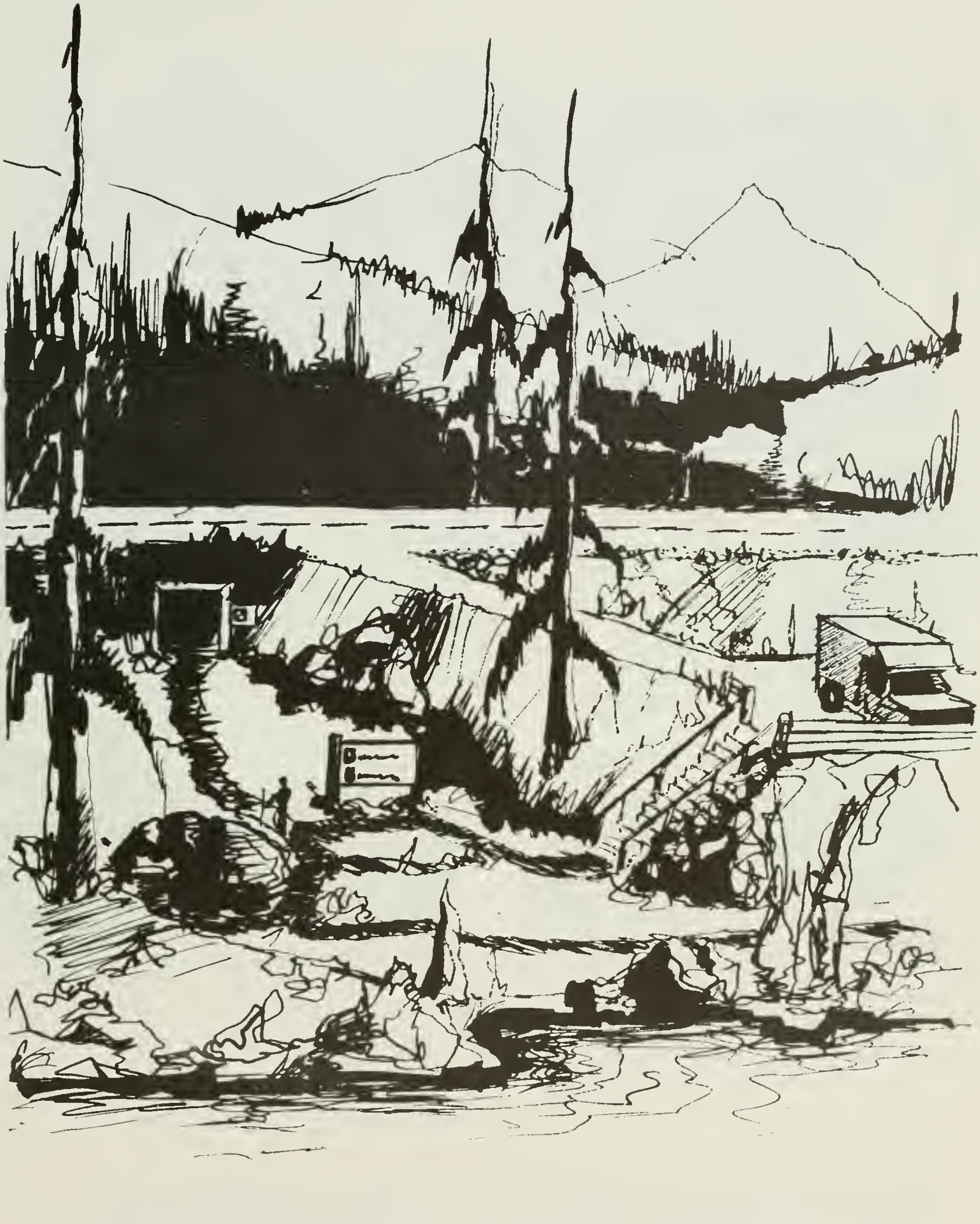
Materials should reflect what is locally available. Rock and ground cover should blend naturally with grasses for erosion control. Rock and wood walls should conform to regional expression of uses of materials. Natural landscape colors can be used to advantage in framing and screening of views.

Recreation Trails

An integral part of the Canyon is its network of recreation trails. Hiking and equestrian trail links have been suggested as linking elements between recreational features in the Canyon area. Physical design solutions should reflect the need for physical and psychological separation, orientation and designation points.

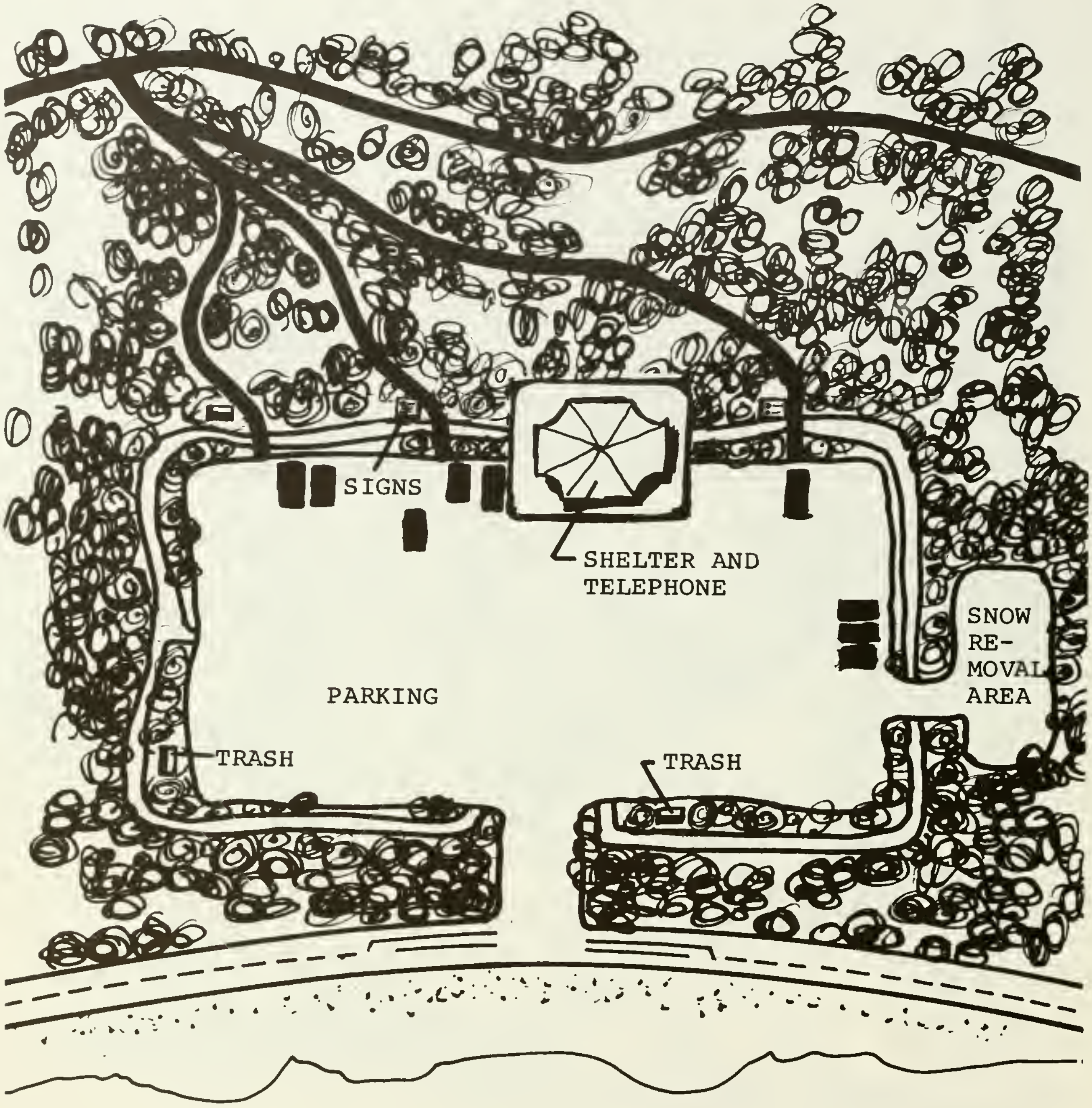
A. Construct access roads which serve intensive recreation areas to good safety standards and of sufficient width to handle the volumes of traffic anticipated;

B. Continue to conserve the Primitive Area presently maintained by the U.S. Forest Service in its natural state (foot and horse trails should remain the sole method of access to this area);



AN INTEGRAL PART OF THE CANYON IS ITS NETWORK OF RECREATION TRAILS. PHYSICAL DESIGN SOLUTIONS SHOULD REFLECT THE NEED FOR PHYSICAL AND PSYCHOLOGICAL SEPARATION, ORIENTATION, AND DESIGNATION POINTS. PARKING FACILITIES SHOULD BE PROVIDED AT MAJOR ACCESS POINTS TO THE TRAIL SYSTEMS.

Figure I-30



ADEQUATE PARKING AREA SHOULD BE DEVELOPED TO SERVE PUBLIC RECREATIONAL USE FACILITIES (i.e., BIG SKY SNOWMOBILE TRAIL, ETC.). INFORMATIONAL SIGNING, TRAIL MAPS, SHELTER, TELEPHONES, AND RELATED FACILITIES WOULD BE NECESSARY TO SUCH AN AREA. ENTRANCE AND EXIT POINTS FROM THE HIGHWAY SHOULD BE CLEARLY MARKED AND CROSS-TRAFFIC TURN LANES PROVIDED. LARGE PAVED AREAS SHOULD BE VISIBLY SCREENED FROM GENERAL VIEW.

Figure I-31

C. All motor vehicles should be restricted to existing roads and trails. Restrict off-road vehicles to paved surfaces within the Canyon. (Uncontrolled access by vehicles in this area would result in very serious erosion problems);

D. Supervise and maintain all trail systems;

E. Provide adequate access and parking facilities for all trail systems (paved parking facilities should be provided for users of the Big Sky Snowmobile Trail);

F. Clear a right-of-way of eight to ten feet for new heavy-use trails (this makes trail maintenance easier and encourages the undergrowth vegetation along the trail);

G. Do not fell trees except when it is impractical to build around them;

H. Take care to avoid unnecessary disruption of trail side areas when mechanical means are used to clear the trails;

I. Use simple methods of interpretive sign presentation along trails (interpretive signs should be carefully designed and placed for minimum visual intrusion upon the landscape);

J. Build trails to follow the contour of the land (unless heavily used, trail surface material should be made of native material or grass, In heavy use areas, woodchips, fine shale, gravel, or crushed rock may be used).

GENERAL CONSTRUCTION GUIDELINES

Preserve notable landmarks, and areas of historical architectural or aesthetic value, and promote the preservation of other buildings and features that provide continuity with past developments.

Match development to land capabilities; developments should be located on sites which meet requirements naturally, thus obviating the need for grading, earth moving, landscape planting and the like.

Care should be taken so that houses, service stations, and other inappropriate structures do not preempt the few sites that would be best for schools, open space, historic sites, and scenic rest areas.

Unsightly uses such as junk yards should not be allowed. Those existing or indispensible unsightly uses should be inconspicously located or screened from the highway and residential districts by effective planting, grading, and fences.

Quarries and other excavations should not be visible from the road. Those close to the roads should be screened from view. Abandoned quarries and excavations should be restored to an attractive appearance through landscape design.

All landscaping for buildings or roads should be keyed to the natural plant communities found in that area. Existing specimens and stands of trees and other plant materials of outstanding value should be identified and preserved.

If areas are cleared for access to subsoil material, the topsoil should be saved (this includes parking lots, building sites, and new roadways) for replanting of the area and landscaping.

All structures should be designed to take into account snow loads of 200 pounds per square foot.

PUBLIC FACILITIES AND SERVICES

School Construction

All school sites should provide isolation from noise, dust, and traffic hazards. Each site should be easily accessible to the areas it serves and properly protected from traffic and other accident hazards.

Each site area should be sufficient to provide adequate space for all school facilities and activities. The land area for an elementary school should be five acres to serve up to 300 students plus one acre for each additional 100 students. Middle schools up to 300 students, ten acres, plus one acre for each 100 additional students.

Equally important, are some additional suggested standards for use in selecting or developing the school sites:

A. Work with the landform as opposed to grading it into a single flat pad where terrain on the site is rolling;

B. Return significant vegetative features;

C. Design paved pathways, court game areas, parking lots and other areas where significant soil disruption is contemplated with provision erosion controls;

D. Incorporate architectural design and materials that fit the landscape of the Canyon into school designs; and

E. Avoid chain link fences around school sites.

Solid Waste Disposal. Until such time as a proper and suitable means is found to take care of solid waste disposal it is recommended that all solid wastes be "exported" to existing disposal sites outside the Canyon.

Sanitary Waste Disposal. Construction of drainage systems and sewers should be done in a manner to minimize the disturbance of the natural resources of the area. Due to the great natural resource value of the Gallatin River and its tributary streams, sewage and drainage lines should not be located within a 100-foot distance from any water and/or bank area to prevent contamination of soils and waterways. All sewage disposal systems should be designed so that there is no direct discharge into any water course.

All sewage disposal facilities should be inspected by the Gallatin County Public Health Department for compliance to and with local standards before any actual operational use. Pit priveys conforming to state and county standards should be permitted in campground areas only.

Utility Lines. In general, the main priciple involved in the location of transmission lines and facilities is reducing their visibility. The following guidelines should be followed wherever possible:

1) Consolidate power and telephone easements, preferably underground;
2) Consider placement underground and relocation of existing overhead lines;
3) Place lines along the edges of differing types of land uses (special emphasis should be given to the preservation of natural forest and timber growth);
4) Avoid sites of great scenic value, including prominent ridge lines, riparian areas, and the barren sides of mountains or hilly terrain; and
5) Paint metal poles dark or subdued landscape colors or leave in natural wood colors; and they should be of a clean, simple geometric standard.

Street Lighting. Light standards of appropriate scale and luminosity should be used throughout the Canyon area. Flamboyant styling of poles and mercury vapor lights of the bluish-green cold range should be avoided. Subdued pole styling and color with soft warm tones are more appropriate to the Canyon landscape.

Generally, highway lighting is considered to be undesirable and should be avoided except for the following:

1) Illuminate the highway surface in areas of high pedestrian concentrations;
2) Illuminate major intersections with high traffic volumes;
3) Illuminate facades of historical and other public buildings; and
4) Illuminate areas in which pedestrian safety would be increased by illumination.

SIGNING CONTROL

For many users, enjoyment of the Canyon environment will be enhanced by proper identification of features, trails, special sites, and crossings. A standardized system of signs should be established to act as public facility and informational guides and they should be of a character unique to the region. These signs should have the trail and route signs worked with standard federal symbols, but with distinctive color backgrounds for added recognition and visibility.

The following standards should be adhered to regarding all highway informational and commercial signing:

1) Restrict all signs in size, and eliminate flashing or scintillating signs;

2) Do not permit offsite advertisement signing (provisions should be made to have existing off premise advertising removed);

3) Do not let sign size interfere with or dominate the area surrounding the site of the sign;

4) Ensure that sign illumination, if used, is directed at the sign and not the surrounding area (except for historical sites, lighting should be turned off when the business or service is closed);

5) Construct signs of material, color, and design which are compatible with the surrounding architectural development (garish material and shapes should be avoided);

6) Ensure that the designs have unity, using a minimum of copy, and with the proper use of lettering (improper grouping of copy will nullify good design); and

7) Ensure that on commercial buildings, signs that fit within the architectural order of the facade do not obscure or damage the building's integrity, and make for easy identification.

A STANDARDIZED SYSTEM OF SIGNS SHOULD BE ESTABLISHED FOR USE THROUGHOUT THE CANYON, AND THEY SHOULD BE OF A CHARACTER UNIQUE TO THE AREA. IT IS IMPORTANT TO ELIMINATE BILLBOARDS AND OTHER UNSIGHTLY SIGNS FROM THE LOCAL ENVIRONMENT. COMMERCIAL SIGNS SHOULD FIT WITHIN THE ARCHITECTURAL THEME OF A DEVELOPMENT--NOT OBSCURING OR DAMAGING THE DEVELOPMENT'S INTEGRITY, BUT MAKING FOR PROPER IDENTIFICATION.

Figure I-32

DRAFT ZONING ORDINANCES

The preliminary draft ordinances included herein are not intended to constitute a complete zoning ordinance. They are designed only to guide development in the Canyon toward environmental quality preservation and control.

I. LAND USES

A. Natural Areas

Land use areas which shall be designated in this category include riparian areas, the Spanish Peaks Primitive area, hazardous areas (innundation, slide, and other geologic hazard areas), and high elevation areas.

1. Purpose and Intent. Districts categoriezed as Natural Areas are established to provide for the preservation of the environmental quality of areas of extreme sensitivity to change and erosion of areas of extreme scenic quality and of areas important to wildlife habitat.

2. Permitted Uses.

   a. Residential. There shall be no residential development in this area except for those dwellings already established.

   b. Commercial-Tourist Facilities. No commercial-tourist facilities shall be permitted in this area other than existing facilities.

   c. Resource Management. The management of the resources of these areas shall be in accordance with the guidelines as set up under a Multiple Use Management Program.

   d. Public and Quasi-Public. There shall be no Public or Quasi-Public facilities permitted in this area except for the following:

      (1) Fire protection facilities and access roads,
      (2) Water crossing structures, and
      (3) Maintenance and service facilities - to include those necessary for permitted recreational activities.

e. Recreational. The primary aim is to protect the environment from excessive uncontrolled use, fire prevention, sanitation, maintenance of water quality, and public safety. Recreational uses will be permitted accordingly.

3. Hazardous Areas. Land subject to known hazards such as landslides, seismic movement, and flooding shall be:

   a. Set aside by appropriate legal instrumentation such as covenants, easements and dedications as permanent non-use areas, or

   b. Suitably improved with such corrective measures that will limit the hazard and make the land suitable for the intended use, provided, however, that such corrective measures are designed in a manner not to cause substantial risk of environmental harms such as erosion.

B. General Forest Area

1. Purpose and Intent. This district is intended to provide areas for the development of recreational facilities and single-family residences with related accessory uses and structures. It is intended that this district remain an extreme low density area with the goal being to preserve the natural scenic and environmental quality of the area.

2. Permitted Uses.

   a. Residential. This area shall be zoned for one dwelling unit per 40 acres. Accessory buildings are permitted to include related agricultural buildings, garages, and guest houses intended for nonpermanent residents.

   b. Tourist Residential and Commercial. There shall be no tourist residential or commercial facilities permitted in this zone.

   c. Outdoor Recreation. Outdoor recreational facilities within the General Forest area shall be limited to the following:

      (1) Hiking trails,
      (2) Riding trails, pack stations, corrals, stables, and accessory facilities, and

(3) Snowmobile trails.

d. Resource Management. Resources in this zone shall be managed in accordance with the principals of a multiple land use management program.

e. Public and Quasi-Public. There shall be no public or quasi-public facilities in this zone except for the following:

(1) Roads and water crossing structures,

(2) Utility and transmission lines and stations,

(3) Overhead and underground utilities - all new installation of utilities shall be placed underground or screened,

(4) Fire protection facilities,

(5) Historic sites,

(6) Water storage tanks and reservoirs, as pertaining to the section on water supply,

(7) Sewage lift stations,

(8) Electrical substations, and

(9) Broadcast and relay stations.

C. Residential Areas

1. Purpose and Intent. The Residential District is provided to establish low to medium density residential land use for single and multiple family dwellings and related accessory use.

2. Permitted Uses. None but the following uses, or those allowed pursuant to a previous administrative permit shall be permitted.

a. Residential.

(1) Single family dwelling units at no more than one dwelling unit per 10 acres.

(2) Guest Ranch facilities at no more than 10 accommodation units per acre.

(3) Accessory guest house, private stables, and buildings related to the land use - such as green houses, swimming pools, garages, and storage sheds.

(4) Planned unit development, at no more than one unit per 10 acres. This may include multiple family dwellings, recreational uses, and facilities designed exclusively for the residents thereof.

b. Tourist Residential and Commercial. There shall be no tourist residential or commercial development permitted in this zone, other than Guest Ranches.

c. Outdoor Recreation. The following outdoor recreational facilities are permitted in this zone.

(1) Private recreation areas,

(2) Hiking and riding trails,

(3) Day use facilities,

(4) Guest ranches and accessory buildings which are designed as non-permanent living quarters. Also permitted are related stables and recreational facilities designed exclusively for the guest ranch usage.

d. Resource Management. Resources in this zone shall be managed in accordance with the principles of a multiple land use management program.

e. Public and Quasi-Public. Only the following public and quasi-public facilities are permitted in this zone.

(1) All those permitted in the General Forest District except for broadcast and relay stations,

(2) Educational facilities - general,

(3) Water treatment plant,

(4) Fire facilities,

(5) Day care facilities,

(6) Medical facilities, and

(7) Churches, temples, and other places of religious worship.

f. Commercial. The only commercial facilities permitted in the Residential District are home occupations and real estate sales offices.

g. Site Development Standards. The following plans are to be included prior to construction:

(1) Installation and management of water and sewage facilities. Wherever possible, developments are to connect to a public water supply and sanitary sewer system. Where this is not feasible, private facilities are to be constructed in accordance with County Health Standards and recommendations of the Comprehensive Plan.

(2) Studies of surface geology and soils to indicate problems and their solutions.

(3) Solid waste disposal plan.

h. Building Height Limit. The maximum height limit shall be three stories or 35 feet, whichever is least.

3. Non-conforming Structures and Uses.

a. Non-conforming Uses of Land. A lawful use of land on the effective date of this regulation or its amendment which is made no longer permissible by the terms of this regulation or its amendment may be continued if it remains otherwise lawful, subject to the following provisions:

(1) No such non-conforming use shall be enlarged, increased or extended to occupy a greater area of land than was occupied by such use at the effective date of the adoption or amendment of this regulation.

(2) No such non-conforming use shall be moved in whole or in part to any other portion of the lot or parcel being occupied by such use at the effective date of the adoption or amendment of this regulation.

(3) If any such non-conforming use ceases for a period of more than 180 days any subsequent use of land shall conform to zone regulations for the zone in which it is located. The term "ceases" as used in this case, shall mean that the activity in question has not been in operation for a period of 180 days.

b. Non-conforming Structures. Where lawful structures exist that could not be built under the terms of this regulation, such structures may be continued so long as it remains otherwise lawful, providing that:

(1) No such structure may be enlarged or altered in a way that increases its nonconformity.

(2) Should such structure be moved it shall thereafter conform to the regulations for the district to which it is relocated.

(3) Any building existing on the effective date of this ordinance which is nonconforming only as to setback from a public road may be expanded in any direction except closer to said public road.

4. Location. In order to minimize the impact of construction on the environment to assure the safety and comfort of the residents and to build at the most reasonable construction costs, development of residences should not be located in the following areas:

a. Areas of greater than 30% slope,

b. Areas with unstable soils,

c. Critical wildlife habitat and migration areas, or

d. Established open meadows.

D. Commercial Service District.

1. Purpose and Intent.

a. To provide adequate space for motels, hotels, and related facilities to house and provide services for tourist visitors to the region in appropriate locations.

b. To assure adequate areas in appropriate locations for commercial services necessary for the population within the region.

c. To provide for the convenient location of public service facilities.

None but the following uses or those allowed pursuant to a previous administrative permit which are found to be appropriate and similar in nature, shall be permitted.

2. Uses Allowed as a Matter of Right.

a. Local retail business or service establishments such as service stations, grocery stores, bakeries, drug stores, barber and beauty shops, clothes cleaning, laundromats, variety stores, hardware stores and restaurants.

b. Business, professional, and medical offices.

c. Commercial parking lots for passenger and delivery vehicles.

d. Social halls and lodges.

e. Accessory uses and buildings customarily appurtenant to a permitted use such as incidental storage facilities.

f. Living quarters when accessory to the principal permitted use.

g. Signs which pertain only to a permitted use on the premises; which do not project above the highest point of the roof; which are integral with the building, or attached flat against the building, or which are suspended entirely beneath the canopy portion of the building. The aggregate area of said sign or signs shall not exceed one (1) square foot for each one (1) linear foot of building frontage. Moving signs, flashing and oscillating lights shall be prohibited. Signs shall only be illuminated at such times as said uses are open for business.

3. Uses Permited After Securing Approval of Governing Agency

a. Dwellings.

b. Free standing signs when pertaining to a use permitted on the premises.

c. Public and quasi-public buildings and uses of a recreational, educational, religious, cultural, or public service type but not including corporation yards, storage or repair yards, or warehouses.

d. Similar Uses - Any other commercial use or service found to be consistent with the purpose of this article and which is of the same general character as the above permitted uses.

4. Outdoor Recreation. All those recreation uses permitted in the Residential District are permitted in the Commercial District.

5. Resource Management. Resources in this zone shall be managed in accordance with the principles of a multiple land use management program.

6. Site Development Standards

a. Building height shall not exceed three stories or 35 feet, whichever is least.

b. All sales, displays and storage shall be conducted within an enclosed building.

c. Off-street parking shall be provided in accordances with the following:

(1) For commercial and office uses: One (1) off-street parking space for each two hundred (200) square feet of gross floor area.

(2) One (1) off-street parking space for each ten seats in any place of public assembly.

d. Minimum setback for buildings and structures shall be fifty (50) feet from any property line and one hundred (100) feet from the centerline of any public road, whichever is the greater..

7. Strip Development. Further development of Commercial Districts in strip zones along roadways shall be prohibited. All commercial development is to be located in Commercial Service Nodes designated as Commercial Districts, except where otherwise indicated. The Commercial Service Nodes are to be developed and designed to accommodate commercial activities and parking areas.

8. Location. Commercial Service Nodes shall be planned so as not to substantially effect critical natural areas. They shall not be located in sites with:

   a. Slope gradients in excess of ten percent (10%),

   b. Geologically unstable area or areas with unsuitable soil,

   c. A natural stream channel within 100 feet, or in

   d. A critical wildlife habitat or migration area.

9. Non-conforming Structures and Uses. (See Article I.D. 3. - A. and B. for content.)

E. Recreation District.

1. Purpose and Intent.

   a. To protect, enhance, and provide suitable areas for recreation in which tourism is recognized as the major industry.

   b. To provide adequate motels, guest ranches, and related tourist facilities to house and provide services for tourist visitors to the region in appropriate locations.

2. Permitted Uses. None but the following uses or those allowed pursuant to an administrative permit which are found to be appropriate and similar in nature, shall be permitted:

   a. Residential.

      (1) Residential dwellings accessory to the permitted recreational use.

      (2) Dwellings necessary for the supervision and maintenance of the recreation areas and trails.

      (3) Guest Ranch accommodations and accessory buildings.

b. Tourist Residential.

(1) Transient accommodations up to 10 units per acre.

c. Outdoor Recreation.

(1) All those permitted in the residential area (private recreation areas; hiking and riding trails, day use areas),

(2) Snowplay facilities, skiing, and snowmobile facilities,

(3) Developed campgrounds and facilities,

(4) Buildings for storage of recreational and maintenance equipment, and

(5) Picnic areas, view points, and rest areas in conjunction with scenic or historic areas. These are to be developed for day use only.

d. Public and Quasi-Public. Those required to directly service and protect the recreational area (such as police facilities, medical, fire facilities, post office, specialized educational, etc.).

3. Resource Management. Resources in this zone shall be managed in accordance with the principles of a multiple use management program.

4. Site Development Standards.

a. Building Height Limits. The maximum building height limit shall be fifteen (15) feet or one story, whichever is least.

b. Setbacks. All developments shall be setback 200 feet from the center line of any road fronting or passing the development on any side.

c. All developments and buildings shall be screened from public view of motorists by retention of natural growth or installation of landscaping.

d. All construction shall include preparation and adherance to an erosion control plan, including ski slopes, roads and parking lots.

e. Areas which are or may become denuded are to be revegetated.

f. All construction plans are to be designed not to interfere with the natural drainage pattern.

g. Strict limitations or treatment and disposal of sewage effluent pursuant to approval by the County Health Department and other appropriate governing agencies.

h. Building designs shall take into account snow loads of up to 200 pounds per square foot.

i. Fire control measures for structures and escape routes for residents shall be developed.

II. CIRCULATION ELEMENT

A. Purpose and Intent

1. The purpose of this section is to insure that the construction and maintenance of the circulation elements within Gallatin Canyon will preserve the environmental quality of the Canyon by protecting its natural features and topography; and

2. Provide for the safety and comfort of residents by protection from noise, pollution, and the physical danger of excessive traffic.

B. Site Location

1. Wherever possible the circulation pattern (both roads and trails) should avoid stream channels and buffer zones. Where this is not possible, the crossing of streams shall be by spanning rather than culverts so that the natural stream beds will not be altered.

2. Avoid hazardous areas, areas of unstable soil or geology, and avalanche or slide areas. Where these areas are crossed erosion control and slide prevention measures shall be undertaken.

C. Construction Standards. Construction of roads shall be done in a manner that will minimize the disturbance of the natural resources and scenic quality of the Canyon; and assure the safety of motorists and pedestrians using the circulation routes.

1. Wherever feasible, drainage shall be left in or returned to natural courses. Where sheet flow is picked up in roadside ditches cross culverts shall be spaced to minimize the concentrations of water and thereby the possibility of erosion.

2. Construction diked shoulders or lined roadside ditches wherever concentrations of water would otherwise cause erosion.

3. Stringent clearing specifications are necessary. Trees and other vegetation shall be preserved to the greatest extent feasible in the location and construction of roads. No healthy trees shall be cleared outside the limits of the road or street section.

4. The least amount of road surface necessary will be used to adequately serve the type and intensity of proposed land uses within the developed area, future traffic demand, adequate access for public service and emergency vehicles, and adequate parking.

5. Roadways will have rights-of-way of sufficient size to contain two paved travel lanes, shoulders, safety and snow storage strips with ties to external trail systems, and to provide for adequate natural or man-made landscaping.

6. Construction of all roads and trails shall include erosion control measures to include energy dissipaters for all drainage.

7. Borrow pits along roads shall be prohibited unless the borrow area can be used for turnouts, viewing areas, or needed parking space.

8. Cuts and fills shall be minimized wherever feasible. All snow storage areas and cuts and fills shall be replanted.

9. On seasonal roads which have gradients in excees of 10% a rock base should be provided and adequate cross drainage installed.

10. On seasonal roads which are less than 10% in gradient maintain a previous road surface and treat with a non-toxic or low-toxic chemical dust control. This may require two or more applications each season.

11. Loops, split one-way sections, and occassional steep road grades shall be designed to fit terrain and minimize grading and exposed slopes.

D. Road Designs. Roadways shall be designed so as to encourage slow speed traffic and respect the natural topography of the area by following the existing contours insofar as possible; and to protect the public health and safety.

1. Road design shall consider roadside aesthetics and include flattening roadside slopes, rounding tops of cut slopes, replanting cut and fill slopes, and proper landscaping.

2. Construction plans shall be included to handle snowmelt and runoff, snowdrift, icing, snow removal, and storage areas to facilitate winter service.

3. Road improvements shall include a minimum of 12 feet of pavement for each traffic lane; curbs and separate left turn lanes at all major intersections.

4. Road design must not limit access or movement of emergency vechicle nor include visual hindrances which will create safety hazards for pedestrians and other vehicles.

5. The streets within a cluster development shall provide adequate vehicular circulation for the development and the area in which it is located, including adequate width, radii, and access for emergency vehicles.

6. To the extent feasible road design shall provide for the separation of motor vehicular, pedestrian, and equestrian traffic.

7. Direct access to primary roads shall be minimized through use of controlled access roads in order to eliminate numerous road cuts and traffic conflict.

8. Roads shall be designed and located where possible to serve more than one individual use. All roads, except fire access roads, must be open for public use.

9. All new bridges will be designed to the full width of the approach roadway sections including shoulders. All new bridge structures designed for the Canyon should reflect strong considerations for their aesthetic impact on the environment. Bridge rails should be of the open type design to allow for the viewing of the drivers or passengers traveling across the bridge. Bridge shall accommodate all trail crossings.

E. Private Driveways and Trails

1. These roads may be unpaved but adequate provision shall be made for control of erosion. Where they intersect water course adequate provision shall be made for culverts and bank protection.

2. Collective private driveways shall be encouraged where their utilization will result in better building sites and lesser amounts of land coverage than would result if a public road were required.

3. All trails shall be located away from any sensitive wildlife area, or areas of vegetation which need to be protected.

4. The general construction standards (II.C.) and the following development guidelines (III.) shall be applied to construction of all private driveways and trails.

III. DEVELOPMENT GUIDELINES

A. Construction and Development. Developments shall be planned and constructed so as to preserve the natural environment and scenic quality of the area to include topography, rock outcroppings, waterways, vegetation, wildlife and points of special interest. Areas of special historical, cultural, or archeological significance shall be designated and have covenants set up to protect them.

1. All development shall be planned, constructed, and maintained to:

    a. Preserve the existing trees and natural vegetation to the maximum extent feasible;

    b. Landscape the finished development to suit the natural vegetation of the area and to cause the least possible visual impact on the environment;

    c. Remove all open slash, dead trees and stumps remaining after construction;

    d. Protect the soil of the area by removing and storing for future use the topsoil from the building sites, parking areas, driveways and other locations;

    e. Use the minimum feasible amount of land coverage and the minimum feasible disturbance of soil and site by grading, excavation and other land alterations;

    f. Provide the maximum amount of open space; and

    g. Avoid substantial soil erosion, pollution of waterways, vegetation damage and wildlife injury.

2. No solid or liquid waste materials including soil, silt, clay, sand, and other organic or earthen materials shall be discharged into the waterways of the area (either directly or indirectly).

3. Where mechanical stabilization of the slope is required the devices used are to be screened by vegetation.

4. Vegetation removed during clearing operations shall be disposed of as follows:

    a. Chipping all or some of the cleared vegetation and stockpiling it on the site for later use as mulch or compost; and

    b. Disposal of the balance in the manner and to a location approved by the permit-issuing authority.

5. Earthen materials removed during grading operations or construction shall be disposed of as follows:

    a. Stockpiling and topsoil on the site for use on areas to be revegetated and for landscaping; and

    b. Disposal of the earthen material at a location approved by the permit-issuing authority.

6. Tree Buffer Zone. No grading or operation of heavy equipment shall take place within the area bounded by the drip line of any tree on or off the property. This does not apply to those trees which are within the actual construction area and are to be removed according to the construction plan.

7. Protective Barriers. During construction the permitee shall provide appropriate barriers around all native vegetation proposed for retention.

8. Responsibility of Contractor. The permittee shall be fully responsible for any damage caused to existing trees or other vegetation. He shall carry the responsibility both for his own employees and for all subcontractors from the first day of construction until the notice of completion is filed.

B. Objectives of Antiquity.

1. Prohibition of Grading. No grading, filling, clearing of vegetation, operation of equipment, or disturbance of the soil shall take place in areas where any historic or prehistoric ruins or monuments or objects or antiquity are present. The grading plan shall indicate all such areas on the site and shall indicate the measures that will be taken to protect such areas.

2. Discovery of Antiquities. Whenever during excavation there are uncovered or become apparent any historic or prehistoric ruins or monuments or objects of antiquity not previously accounted for in the grading plan, all work in the immediate area shall cease until the permit-issuing authority shall determine what precautions should be taken to preserve the historic artifacts.

3. Special Areas. Areas of special historical or archeological interest shall be determined and protected. No such building or site shall be altered, repaired, or developed without a permit.

C. Building Sites.

1. The dimensions, shape, and orientation of all building sites shall be determined with maximum regard to the provision of open space, road access, offstreet parking, circulation, recreational, potentials, and other relevant features including snow and icing conditions, spaces between future buildings, light and air, setback variations, and design elements intended to create identity and interest in the development.

2. The creation of building sites through mass pad grading and successive padding or terracing of building sites is prohibited.

3. Every lot in an approved subdivision shall be provided with sanitary sewers connected to an approved sewage treatment and/or disposal facility

D. Parking.

1. Purpose and Intent. The intent of this section is to provide adequate and suitable landscaped off-street parking spaces and emergency parking areas.

2. Parking Spaces Required. At the time of the erection of any building or enlargement of any building, or the development of any area, or any construction which will intensify the use of an area, the following minimum paved off-street parking space with adequate provisions for safe ingress and egress shall be provided:

   a. For commercial and office uses: One (1) off-street parking space for each two hundred (200) square feet of gross floor area.

   b. One (1) off-street parking space for each ten seats in any place of public assembly.

   c. Two (2) off-street parking spaces shall be provided for each dwelling unit.

3. Landscaping. Excepting those portions devoted to driveways and/or pedestrian walkways, all off-street parking facilities abutting a public street shall be bounded by a planting strip with a minimum of ten feet of ground area with width. Types of landscaping shall reflect the natural vegetation of the area.

4. Nonconforming Areas. Existing buildings and developments with non-landscaped parking areas, shall not enlarge or improve the area without making provisions to comply with the above parking codes and to supply adequate off-street landscaped parking areas.

E. Fire Safety Standards

1. Standards. All subdivisions shall be planned, designed, constructed, and maintained so as to minimize the risk of fire; and to permit the effective suppression of fires in order to protect persons, property, improvements and forested areas. Measures shall include:

   a. The placement and design of structures in such a manner as to minimize the potentialities of flame spread and to permit access for fire fighting equipment;

   b. The provision of adequate fire fighting facilities on site;

   c. An adequate water supply and water distribution system to fight fires on site;

   d. Appropriate clearance of inflamatory materials;

   e. Provision for proper storage, location and maintenance of all combustible, explosive, or any other materials or items of potential incendiary character;

   f. The dedication of appropriate easements of access for fire protection equipment from roads within the subdivision to the boundaries of the subdivision in areas of possible fire hazard;

   g. The provision, where necessary, of firebreaks; and

   h. The availability, through a fire protection district or otherwise, of fire protection services adequate to fight fires that may occur within the subdivision.

2. Adequate fire facilities shall be drawn into all construction plans - they should also include plans for forest fire combatment.

3. Fire stations are to be completed as warranted by development. Reciprocal arrangements should be made with the U.S. Forest Service for forest fire combatment.

4. On the main and alternate fire access roads provide at least a 1-1/2 lane road standard and maintain these roads at a standard compatible with passenger car access. All fire roads should have appropriate signs.

F. Signing.

1. Design. Signs shall be designed to be an integral part of the building or structure to which they pertain. Sign design shall relate to the building design and usage.

2. Limitations.

    a. Signs will be limited to identifying the premises or occupation where they are located.

    b. No off-site advertisement signing will be permitted.

    c. No billboards or fence post advertising will be permitted.

    d. Signs will not be of the rotation type, nor include flashing or scintillating lights. Signs extending above 35 feet or above the roof of the building they are on will be prohibited.

3. Residential Signing. Signing shall be permitted in the Residential District as follows:

    a. Name plates not to exceed one square foot in area. They shall display only the name of the owner and/or resident of the property.

    b. Identification purposes pertaining to any home occupation or office, not to exceed twenty-five (25) square feet in size.

    c. For rent, for sale, and signs for similar purposes not to exceed one (1) per lot, and four (4) square feet in area.

    d. Warnings against hunting, trespassing, etc., on private property will be permitted not to exceed one (1) square foot in size.

4. Commercial Signing.

   a. Signs shall be allowed which pertain only to a permitted use on the premise.

   b. Wherever possible, signing for a cohesive or integrated commercial area should be clustered in a central, convenient location.

5. Recreation Area. Signs shall not exceed twenty-five (25) square feet and shall be located in an area adjacent to the advertised use.

6. Identification and Information Signs.

   a. Such signs should be placed to adequately identify features, trails, historic sites, crossings, etc.

   b. Informational signs indicating rest areas, vistas, and general gas-food-lodging signs shall be placed along the highway at appropriate sites approved by the State Division of Highway---not to interfere with the surrounding landscape.

   c. These signs shall be constructed to be in full accord with all other signing regulations - to increase the enjoyment and facilitate use of the Canyon area.

7. Safety Hazards.

   a. No sign shall be located or maintained which prevents free egress or ingress to any door, driveway, window, or fire escape - or which is a possible hazard to pedestrians or traffic.

8. Existing Non-conforming Signs. Provisions should be made to alter existing signs so that they comply with these regulations.

G. Utility Lines and Facilities and Lighting.

   1. All electric power distribution lines, telephone lines, gas distribution lines, cable television lines, and appurtenant facilities shall be installed underground when at all possible.

2. The following types of lines and facilities may be excepted from the above requirement providing that such facilities shall be located and designed so as to harmonize with the area, and shall be appropriately screened and landscaped. In appropriate instances, all or part of utility transformers and service terminals shall be flush with or below the surface of the ground at the point of installation.

   a. Poles without overhead lines used exclusively for fire or police alarm boxes, lighting purposes or traffic control;

   b. Equipment appurtenant to underground facilities, such as surface mounted transformers, pedestal mounted terminal boxes, meter cabinets and concealed ducts.

3. The location, design, installation and maintenance of electric power distribution lines, telephone lines, and gas lines, cable television lines, and appurtenant facilities shall be carried out with a minimum disturbance of soil, vegetation and site as is possible.

4. Street lighting systems shall be appropriate to the character and nature of the physical setting.

H. Sanitary Sewers and Storm Drainage.

1. Sanitary Treatment Service.

a. Each lot or condominium unit in a subdivision shall have a connection to a sanitary sewage disposal facility that has the capacity for collection, and that has been installed under the approval of the Public Health Department.

b. Design of septic tank systems shall adhere to Gallatin County Standards except that the minimum distance to any stream from any leachfield shall be one hundred (100) feet.

c. All sewage disposal systems shall be designed so that there is no discharge from said system to any water course.

d. Pit priveys conforming to State and County standards may be permitted in campground areas only.

e. All sanitary sewage facilities are to have the physical and legal capacity to collect and treat such sewage; and each developer is to make a legal binding commitment to supply such facilities.

f. Sewage lines will be constructed of a material and in a manner that minimizes the risk of sewage seepage or breaks.

g. No storm drainage channel, line, or facility shall be connected to a sanitary sewer system.

2. Storm Drainage.

a. Construction of developments and circulation patterns shall be designed to protect against inundation, flood hazard, sheet overflow, and ponding of local storm waters.

b. All water shall be discharged into a storm channel controlled for erosion, or a storm drainage system that assures that the waters drained from the development will not deliver to streams, rivers and lakes of the Canyon pollutants, including sedimentary materials of any substantially greater quantity than would occur in the absence of subdivision, improvement and use.

3. General Construction.

a. Oversize Lines. When such facilities will be necessary to carry sewage and storm waters from locations exterior to the development site, oversize sewage and storm drainage lines shall be required in a size excess of that necessary for the development site;

b. Natural Areas. Construction of lines and facilities in a subdivision shall be done in a manner that will minimize the disturbance of the natural resources of the area.

I. Water Supply.

1. Each lot and/or development shall be supplied with an amount of water:

a. Adequate for its intended use; and

    b. Adequate to fight fires involving structures on the site.

2. To determine an adequate water supply the following considerations must be made:

    a. Existing and future commitments of the water;

    b. Existing and future demands on the water supply;

    c. Ability of the area to supply water; and

    d. The quantity and quality of the water required.

3. Oversize water facilities may be required of a development when it is deemed necessary to supply adequate water to locations exterior to the development site..

MANAGEMENT AND MONITORING PROGRAMS

The extraordinary nature of Gallatin Canyon points up the necessity for approaching its management with a broader perspective than may usually be appropriate. The suggestion has been made that the landowners represented in the Canyon -- both public and private -- develop a Multiple Land Use Management Program with common objectives for preserving the Canyon environment. While this task is not within the scope of this study, the liberty has been taken to develop suggested guidelines for Forest Management, to develop Water Quality Monitoring Program suggestions, and to suggest a computer-oriented inventory management technique (Live Atlas).

FOREST MANAGEMENT

A detailed study and analysis of timber harvesting practices was recently made by a task force of Forest Service scientists and resource managers and their report and recommendations were published in 1971*. Although the report was prepared for the National Forests in Wyoming, many of their recommendations are applicable to the Gallatin Canyon area and have been incorporated in the following list of forest management recommendations. Local information from state, federal and private land managers in the Gallatin Canyon was reviewed and incorporated as deemed appropriate for the purpose of this study.

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*"Forest Management In Wyoming". (1971.)

It is not the intention of this study to provide specifications for governing logging practices in Gallatin Canyon but rather to provide a general guideline for managing the forest resources in harmony with the stated objectives of the complete study.

Many of the recommendations have been in practice on the Gallatin Ranger District for several years but others are worthy of further consideration in multiple use management decisions. Obviously, some of the recommendations are not economically feasible for private lands. Intrinsic values realized in wildlife and potential recreation benefits do not provide income to the private landholder unless he can find some means of capitalizing on them. The execution of the land exchanges currently under negotiation will help to solve some of these problems by consolidating blocks of public and private land ownership. The development of a comprehensive land use plan for the Gallatin Study Area will necessitate close cooperative efforts between all property owners, local citizenry, and governing agencies if the results are to be harmonious and equitable.

Basic Recommendations. The basic visual character of Gallatin Canyon should be kept dominant, and all other proposed land uses should be made subordinate to and harmonious with this objective.

To accomplish this objective necessitates that all land management practices be considered in respect to their impact upon wildlife, recreation, scenic quality and watershed values. To provide a means of attaining the stated goal it is necessary that a clear and comprehensive forest management plan be prepared for Gallatin Canyon. The development of such a plan will of course require cooperative participation from the composite resource managers and land owners as well as the voluntary adoption of the plan after it has been developed.

Within the Gallatin Canyon Study Area the management emphasis should be in multiple-use planning with particular attention given to the long range impacts of timber harvesting upon the other land uses.

Timber Harvesting and Management. Cutting prescriptions should be made on an individual stand basis, considering the most appropriate land use or uses as well as the silvicultural and ecological needs.

Clearcutting should continue to be used as the prime silvicultural prescription in the initial harvest cuts of Lodgepole pine stands to accomplish:

1) Control of disease and insects.
2) Conversion of over mature stands to productive young growth.
3) Continuous production and growth of high-yield stands.

The maximum size of clearcut units should respond directly to the specific characteristics of the harvest area. Particular emphasis should be placed upon the prior evaluation of potential impacts upon:

1) Natural regeneration.
2) Soil stability.
3) Water quality and stream flow.
4) Aesthetic quality.
5) Recreation.
6) Wildlife and wildlife habitat.

The boundary configuration of clearcut units should be designed so as to appear as natural as possible when viewed from a long range distance and most particularly from State Highway 191. A visual analysis should become standard procedure for determining the placement and/or use of clearcuts if the basic character of Gallatin Canyon is to remain dominant.

Timber sale contract requirements providing for protection of live stream channels from unnecessary disturbance and from clogging with logging residue should be strongly enforced.

Procedures should be developed for determining; (a) the kinds and sizes of areas and proportions of watersheds that can be safely clearcut at one time without creating damaging changes in streamflow quantity, quality, or timing; and (b) the nature and magnitude of changes in onsite nutrient content and of eutrophication of streams that may result from soil and vegetation disturbances that attend timber harvesting.

A regeneration check list should be developed for each proposed timber sale, outlining (a) the sequence of events affecting regeneration, and (b) the treatments needed to obtain satisfactory regeneration, including backup treatments to compensate for failure of any one step.

Shelterwood and seedtree cutting methods should be considered in management units where other land uses are also appropriate but are not considered dominant to timber production.

Shelterwood and seedtree prescriptions should be carefully evaluated in terms of stand structure, condition and composition as well as the susceptibility of the residual stand to windthrow before implementation.

Timber harvesting on low yield sites should be restricted to selection cutting if this use is deemed desirable and is compatible with other uses. Economic considerations will probably require that timber harvesting on such sites be conducted in conjunction with larger volume timber sales on adjacent timber stands.

Sanitation and salvage logging in most cases will have to be included with normal timber sale offerings in order to be economically feasible.

The protection and maintenance of big-game habitats, particularly the elk habitat, should be paramount on those management units known to receive high wildlife use or which are essential to seasonal herd movements. Timber harvesting techniques on these units should incorporate appropriate recommendations developed through cooperative wildlife research projects and current wildlife management plans.

Slash disposal should be completed to a degree compatible with the proposed use or uses of the management unit, but in no case should it be less than that necessary to reduce satisfactorily fire hazard and to provide adequate conditions for the natural regeneration of the tree species. Where additional work and expense is necessary for seed bed preparation, it should be provided for and recognized as a necessary cost of renewing the natural resource.

Prescribed burning should continue to be used in fire hazard reduction and in seedbed preparation provided it is done under proper meteorological conditions which are least likely to affect air quality adversely.

No industrial harvest should be undertaken unless adequate funds and manpower are available to do a complete, professional job.

Roads. In permanent road layout and design the relation between the road and the landscape should be clearly established so as to avoid a result suggesting single use.

Existing specifications that temporary roads should be maintained for adequate drainage before winter should be scrupulously observed.

Road location and design should be well coordinated with the landscape considering each of the following:

1) Planning and road design should routinely include thorough exploration of visual alternatives.

2) The visual corridors created by both existing and proposed highways and permanent forest roads should be recognized as requiring special attention.

3) Flexible road design standards, encouraging small scale roads where they are appropriate, should be adopted.

WATER QUALITY MONITORING PROGRAM

Objective of Program. The prime objectives of any water quality monitoring program should be to establish guidelines for the preservation of the quality of the waters in the Gallatin Canyon, and to assure that these water quality guidelines are not violated by man's activity in the Canyon.

A water quality monitoring program should be implemented to assure the highest water quality consistent with beneficial uses for maximum social and economic benefit to the citizens of the area as well as the general public

Beneficial Uses To Be Protected. Recreation and aesthetic enjoyment is one of the prime uses of the waters in the Gallatin Canyon. The high quality of the waters in their natural setting make them something to be enjoyed by recreationist and tourists as well as residents of the area. Also to be considered is the use of the waters in the Canyon for domestic purposes as development increase.

Water Quality Parameters. To protect the present and potential beneficial uses of the waters in the Gallatin Canyon, the following water quality para-meters should be included in any monitoring program:

Dissolved Oxygen
Hydrogen Ion Concentration - pH
Total Dissovled Solids - TDS
Nitrates
Total Kjeldahl Nitrogen - TKN (Organic + Ammonia Nitrogen)
Total Phosphates
Ortho-phosphates
Chlorides
M.B.A.S.
Turbidity
Suspended Solids
Coliform Bacteria
Fecal Coliform

These parameters are not only helpful in detecting domestic or agricultural pollution but described the ability of the water to support aquatic life, and the aesthic condition of the waters.

Sampling Locations. The sampling locations to be included in any monitoring program should include the locations outlined in Figure I-5 (water resources map), and any additional locations found necessary to define the water quality in the Gallatin River and its tributaries.

Sampling Frequency. The entire drainage should be monitored at least once every three months for the entire range of water quality parameters. In problem areas where one or more of the water quality parameters are found to be inconsistant with the established guidelines, additional samples should be collected at shorter intervals. Future developments, agricultural practices, and logging areas should have a monitoring program tailored for the given site.

Monitoring Agency. The Montana State Department of Public Health would be the agency responsible for the specific details and implementation of any water quality monitoring program for the Canyon.

LIVE-ATLAS TECHNIQUE

One of the keys to successful planning and continued area management is the availability and manipulability of useful information. All too often plans and management programs are static representations of pre-existing conditions; whereas for real time planning, a dynamic system is required. A means through which this might be achieved is a computer-centered "live atlas". Basically a "live atlas" consists of a permanent data bank containing the information that is to be mapped and a standard, graphic output format.

One program that can be utilized in a "live atlas" and that is currently experiencing rather widespread use is the SYMAP (from the word synagraphic) program. SYMAP is a computer program (FORTAN IV) for producing maps which graphically depict spatially disposed quantitative and qualitative information. Raw data of every king (physical, social, environmental, economic, etc.) when fed to the computer may be related, manipulated, weighted, and aggregated in any manner desired. By assigning values to the coordinate locations of data points or data zones, several types of maps (contour, conformant, proximal, etc.) may be produced upon demand. There is no important limit on the size of map that can be produced (large maps are produced in strips).

The SYMAP program was first developed by Howard T. Fisher at Northwestern Technological Institute during the autumn of 1963. More recent expansion and development of the SYMAP program have come from a number of individuals at the Laboratory for Computer Graphics, Harvard Graduate School of Design. The SYMAP program is available at a nominal service charge and without restrictions of any kind to all those who may be qualified in its use. Correspondence courses are available.

The SYMAP program is written in FORTRAN IV. The source deck consists of approximately three thousand cards. The program was originally run on an IBM 709 and is now being run at Harvard on IBM 7094's. Comparable CDC and other large capacity equipment have also been used successfully. Advice relating to experience and use of other equipment is available from the Laboratory. Generally, they do not recommend use of smaller scale equipment (although Morton Scripter at San Fernando Valley State College in Northridge, California, has done considerable work with a small capacity computer and the SYMAP programs). For the recommended standard output the printer should be capable of producing eight rows per inch with overprinting. However, six rows per inch can be used and overprinting may be dispensed with.

The SYMAP program is an example of the utilization of a line printer for cartographic purposes. The program will produce choropleth and isopleth maps on an ordinary line printer. It will map distributions, make evaluations and visual correlations. Now it is possible to make rapidly a distribution map, vary class limits, intervals, and symbols and perform a variety of numerical transformations upon the data. It is also possible to map hypothetical distributions derived from statistical or other numerical models.

Although digital computers have many potential cartographic applications, the use of computers to make maps has been limited. The use of coordinate plotters and cathode-ray tube displays are very expensive and as a result have not, as yet, experienced widespread usage.

The sequence of events in the development of a "live atlas" would be as follows:

> Codification: Once the grid cell size has been determined, then the data for each variable, e.g., vegetation, slope, soils, etc., is extracted and encoded cell by cell. Classification of variables into useful categories is a critical function. For example, slope may be classified in ten categories (0-5 percent, 5-15 percent, etc.). Qualitative data may also be organized and classified in a quantitative manner;
>
> Key Punch: Once the data has been encoded, it is then keypunched and placed on a coordinate system relating to the grid cells. Each grid cell will consist of one data record within the computer and will be assigned a list of variables (temperature, geology, precipitation, etc.);
>
> Data Bank: When all data has been keypunched, it is merged into a single magnetic tape which is the "vault" of the "live atlas." Thus a historical record has been established while changes and updating can continue to take place. This phase should be closely coordinated with the monitoring programs that are selected for implementation; and
>
> Maps: It is now possible to print a map at any time of any individual variable for which data was encoded and entered

into the data bank. This is also the first step in developing interpretive analysis. Through the development of modeling and gaming techniques, there is an almost endless list of manipulations, comparisons, and analyses that can be made through the computer. If, for example, each variable is given weighted values in regards to say "restrictions to crossings by overhead power lines," it is then possible to instantly print a map that graphically delineates potential powerline corridors.

The computer centered, "live atlas" offers to its user an efficient, dynamic, and meaningful mode of analysis as well as rapid and easily communicable, graphic material. Hence, it is recommended that the State Department of Planning and Economic Development incorporate such a management tool in all future area planning projects.

ENVIRONMENTAL IMPACTS SUMMARY

ENVIRONMENTAL IMPACTS SUMMARY

With adherence to the proposed Comprehensive Plan developed for Gallatin Canyon, a number of regional impacts might occur on the environment. The major impact will revolve around introducing increased human occupancy into this semi-primitive natural area.

The Plan for the most part proposed little land area for development. New residential areas are limited exclusively to the west side of the Canyon--most particularly to the West Fork area, and incorporate the current Big Sky development. Commercial activities are limited to four nodes along Highway 191, and general recreational uses are proposed for the remaining lands. General forest operations are expected to continue and could be greatly enhanced under a multiple land use management program. Recreational uses and related through-travels are expected to show significant increase as a result of continuing public pressures for leisure time activities.

This impact summary is intended to portray the extent of environmental impact that could occur if Gallatin Canyon develops in accordance with the proposed Plan and general guidelines. Protection of the scenic and natural resources is the main objective. These impact statements seek to answer the effectiveness of the Plan and guidelines in reducing or eliminating adverse impacts within the limits of future land use development set by the Plan.

What are the Probable Impacts on the Natural Environment?

The proposed Comprehensive Plan as outlined will have minimal impact on the natural environment. There will be some effect on the prime wildlife habitats in the Canyon, some interruption to wildlife migration corridors, probable slight change in water quality, increased erosion potential in hazardous areas, increased fire hazards, and some loss of existing vegetative cover.

If the proposed guidelines are followed, there will be opportunities to control spreading development, to limit soil erosion, to monitor water quality, to control fire hazards, and to develop unified Canyon-wide timber management programs.

Specific Impacts

1. Mammals.

IMPACT: The lower elevations of Gallatin Canyon are important winter habitats and migration corridors for the Gallatin elk herds and mule deer. Improper planning, use, and management of activities in these areas would eliminate some of these critical key winter ranges and migration corridors.

Reduction or loss of open grasslands, willow trees, and other evergreen browse species will have the greatest effect on mammals in the region. Loss of natural cover and browse will be harmful due to their value as cover and food for elk, deer, and other wildlife. Destruction or loss of riparian habitat and consequently creek-bottom browse species would result in population reductions among mule deer and other wildlife. Construction in open grasslands will reduce winter feeding areas. Additional residents and recreational travellers to the Canyon increases the probability of accidental road kills, as well as illegal shooting and harassment of wildlife.

MITIGATION: The impact of the proposed elements of the Comprehensive Plan can be signficantly reduced by:

(a) Site planning and design of residential areas in the cluster planning concept, so as not to constrict or create barriers to seasonal wildlife migration movements. Construction should be lightly clustered in migration corridors and "parallel-to" rather than "perpendicular-to" migratory movements, to allow natural avenues of movement undisturbed by human activities;

(b) Limiting commercial development to a minimum number of "nodes" along Highway 191;

(c) Preservation of open grasslands and meadows to avoid disruption to critical winter feeding areas;

(d) Providing for a minimum of disruption to key riparian habitats through very limited construction and development activity; and

(e) Minimizing clearing and construction disturbances to non-grassland areas, and providing revegetation of cleared areas with native species suitable for habitat regeneration.

2. Fish.

IMPACT: The West Gallatin River and its tributaries are important sport fishery waters, the Gallatin River being a designated blue ribbon troute stream. Any increase in siltation and any decrease in dissolved oxygen content could be critical to the fish population. Loss of riparian and streamside vegetation, reduction in streamflows, and any degradation of water quality will result in significant impact to the fish population.

MITIGATION: Impacts on fish can be lessened by minimizing disturbances to riparian vegetation and maintenance of natural flows in the West Gallatin River and its tributaries.

3. Insects.

IMPACT: The proposed elements of the Comprehensive Plan will not substantially alter the behavior patterns of insects; however, there could be major changes in the insect community. Present conditions do not cause much eutrophication, but increased nutrients in any quantity may increase the insect population and significantly change the water quality. Any change in present water quality would result in the elimination of preferred trout food and a change to dipterous fauna, thus spelling the end to trout fisheries.

MITIGATION: Proper control and treatment of water polluting (including siltation), sanitary waste disposal and solid waste disposal will lessen undesirable potential impacts of insect life. Proper removal of waste, control of drainage to prevent ponding and stagnation, and avoiding collections of slash will act as preventive measures.

4. Ground Water Quality.

IMPACT: Ground water sampling and analysis has been done in the West Fork area of the Canyon only. Based on these data and on the proposed elements and guidelines of the Comprehensive Plan, it seems unlikely that water quality levels will change significantly. Of course, a high potential degrading impact is present if guidelines and suggestions relative to sanitary waste disposal are not followed.

MITIGATION: Additional studies will be required relative to each disposal installation to accurately assess their impact on ground waters.

5. Surface Water Quality.

IMPACT: The greatest impact on the quality of surface waters will be from the increased numbers of residents and visitors to the Canyon. Many of the direct impacts will be temporary. Increased siltation will occur during construction stages--particularly of roads and during site clearing. Logging activities will also continue to contribute to stream siltation. Areas of high development density will be subject to unusually heavy surface runoffs as a result of the addition of impervious surface areas. The introduction of untreated natural organic material will result in a degrading impact on surface water qualities. Heavy use of commercial fertilizers could degrade the quality of water--particularly in the West Fork area, where higher density is proposed.

MITIGATION: Close adherence to the suggested development guidelines will offer the best solution to minimizing temporary impacts to surface water quality. Thoughtful design, particularly in specific site planning and road and trail location, together with a minimum removal of vegetative cover, will help lessen the possible permanent impacts of siltation and uncontrolled runoff. Logging activities should be scheduled during the dry season and conducted with due diligence, including installation of drains and waterbreaks and outslope on roads to prevent excessive siltation of year-round streams from erosion of roads and trails. Sanitary waste disposal treatment should be required of all future development and managed in close cooperation with the County and State Health Departments. Water quality baseline parameters should be established immediately to set existing criteria for water quality levels and to then enable effective monitoring programs to be initiated.

6. Air Quality.

IMPACT: Additional resident population and tourists to the Canyon, and associated increased in vehicular traffic, will result in increased exhaust emissions. The use of fireplaces in homes and campsites and the prescription of open burning as a forest management tool will contribute to air pollution in the Canyon. It is not believed these increases will create a health hazard; however, they can contribute to the visible air pollution (smoke and haze).

MITIGATION: It is difficult to lessen the impact of exhaust emissions; however, strict controls on burning can keep smoke generation to a minimum. Smoke emissions from prescribed open burns can be controlled and directed away from sensitive areas, when conducted under proper atmospheric conditions.

7. Acoustic Quality.

IMPACT: Development as proposed in the Comprehensive Plan will result in increases in the ambient noise levels in the Canyon. This is a result of partial change from a rural, natural environment to a residential/recreational environment, where people are present in increasing numbers. The increase in snowmobiling and other related winter-recreation activities will definitely increase local noise levels, having an impact on human and wildlife populations.

MITIGATION: The severity of impact on acoustical qualities in the Canyon will depend on the rate of development and the types of recreation activities pursued. Restrictions and eventual control over noise-generating equipment (i.e. snowmobiles, construction vehicles, etc.) will reduce noise levels.

8. Fire Hazard.

IMPACT: Any increase in man's activity will increase the potential fire hazards. There is currently no fire protection service available to Canyon residents except through agreement with the Forest Service, and this is limited to nonstructural fires.

MITIGATION: Plans are underway for the possibility of improving fire protection services within the Canyon. Discussion has so far centered around a proposed Volunteer Fire Department, perhaps in association with the Big Sky Development. Close cooperation between the U. S. Forest Service and any volunteer unit is suggested in developing any plans.

9. Geology.

IMPACT: Although available geologic data is limited, certain potential impacts could occur within the identified hazardous areas. The potential for landslides or other mass-gravity movement is present throughout the area. The cretaceous age black shales (thermopolis formation) are most susceptible to mass-gravity movements, and particular caution must be taken during construction in these areas. A high potential for major seismic activity offers possible impact within the Canyon.

MITIGATION: Specific and detailed site investigations should be conducted to determine the suitability of each area for any proposed development. Roadways, building foundations, and other construction should be designed to recognize the potential for landslides and other mass-gravity movements present throughout the entire area. In areas of old landslides, water should not be introduced into the slide mass, as this could easily set the slide area in motion again. As the region is active seismically, planning and development design should incorporate maximum earthquake safeguards.

10. Soils.

IMPACT: In general, the soils within the Canyon area exhibit moderate to severe limitations for development*--particularly for building foundations, road and trail construction and sanitary disposal fields. Soils rated as moderate have limitations that need to be recognized, but can be overcome with good management and careful design. A severe rating indicates the limitations are severe enough to make a particular use questionable. It is probable there will be little development impact on soils in the area, if the Comprehensive Plan and development guidelines are followed.

MITIGATION: To facilitate minimizing the impacts on soils, it is suggested that detailed site investigations be conducted in development areas prior to actual construction. Detailed local investigation would aid in assessing specific soil characteristics within an area. Data generated could then be used as a planning aid to identify problem areas and recommend solutions. Surface soil disturbances should be kept to a minimum, with specific revegetation plans implemented as soon as possible after disturbance.

11. Vegetation.

IMPACT: Two immediate problems having an impact on vegetation in the Canyon are the dwarf mistletoe infections and the mountain pine beetle infestations. Current surveys indicate these problems are severe and control measures are needed immediately to prevent possible major impact in the Canyon. Additional impact to vegetation will be from improper timber harvest and general construction activities, resulting in loss or damage to existing vegetative cover. This in turn would seriously affect the stability of soils and quality of wildlife habitat in the area. Major problems exist in land management, principally due to the lack of any single comprehensive management plan covering the canyon-wide planning area. Single use planning frequently dominates, destroying any possibility for multiple use concepts.

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*Nielsen (1971)

MITIGATION: Development and utilization of multiple use management plans with common goals and guidelines can do much to lessen the impact on vegetation. This will require a separate analysis for each individual management unit for its most advantageous use or uses, and must consider the long term impacts on land use options.

A priority of management should be to obtain early control of both the insect and the disease problem. The feasiblity and development of alternative control methods requires more research before any proven methods can be utilized with any assurance of effectiveness.

Extreme care should be exercised in development within the Canyon to insure as little loss or damage as possible to the vegetative cover. Sensitive cutting prescriptions are necessary to control harvesting techniques and cleanup procedures, particularly when the cut over area is visible and where other uses might prevail.

12. Climatic Elements

IMPACT: The proposed elements of the Comprehensive Plan will not effect the local climate; however, several conditions do exist that should be considered when planning for future development uses.

MITIGATION: Due to possible heavy winter snowfall accompanied with occasionally strong winds, care should be taken in locating ski lifts, trams, and outdoor recreation activities. Areas subject to cold air ponding and correspondent temperature drops should be avoided for outdoor activity and living facilities. Periods of heavy precipitation should be avoided for construction purposes because they may create or aggravate flooding problems and cause water pollution.

What are the Probable Impacts on the Cultural Environment?

The proposed Comprehensive Plan for Gallatin Canyon will have a major impact on the existing cultural environment of the region. The plan itself identifies only major land uses, and these have only a potential impact. The actual impact in terms of additional homesites will depend upon real development plans. The opening of the Big Sky recreation complex, with its potential seasonal addition of 3000 - 6000 persons to the Canyon, will be the overriding cultural impact upon the area. The principle of multiple use management must remain dominant to any single use of the integrity and the character of the Canyon are to be maintained. Only this form of management will continue to afford activity in outdoor recreation, range utilization, timber production, and watershed and wildlife management.

Specific Impacts

1. Existing Land Uses.

IMPACT: Elements of the proposed Comprehensive Plan will disrupt and eventually displace some of the current land uses. The West Fork area will experience most of this disruption, particularly as a result of the Big Sky Development and the pending land exchanges. Existing commercial businesses along Highway 191 will also experience change in the way of potential new customers and possible additional business establishments. Completion of the Big Sky project and additional development proposed under the Comprehensive Plan will undoubtedly create increasing pressures on recreational resources in the Canyon. Without specific multiple use management plans, such increasing pressure could result in the degradation or complete loss of a recreational resource.

MITIGATION: Specific development planning should be designed within the framework of the Comprehensive Plan to protect the environment of the area from degradation and to insure the compatibility of existing and residential proposed land uses. Utilization of cluster planning and the "node" concept for commercial establishments will minimize potential impact upon the visual, natural, recreational, and wildlife resources of the Canyon. Developing a common-goal multiple use management plan for both public and private land ownerships will also provide the opportunity for utilizing the environment to its best possible potential.

2. Circulation.

IMPACT: Highway 191, running through the Canyon, will experience additional traffic loads as a result of expanded residential and recreational development. While the expected additional traffic generated by complete development of the proposed Comprehensive Plan will not bring the average daily traffic figures beyond the present capacity of the road, it is strongly indicated that speed controls will be necessary. Further impact can be expected on the highway by increasing amounts of through truck traffic. Existing roads in the Canyon will experience the impact of additional traffic--primarily from recreation-users. The road serving the West Fork drainage will, of course, experience the full impact of the Big Sky development; however, this road is currently being widened and improved to handle the expected increase.

MITIGATION: The overall impacts of increasing traffic can be reduced by specific speed controls as well as by initiation of an on-going maintenance and improvement program. Necessary improvements to the highway, secondary roads, and the trails should adhere to the suggested development guidelines.

3. Demorgraphic Environment

IMPACT: The proposed Comprehensive Plan, of developed to potential buildout, may create the second largest center of population in Gallatin County. With the Big Sky project, "some permanent population will develop, but the transient tourist population will be the overriding impact upon the area."* This population could vary between 3000 to 6000 persons.

MITIGATION: It is not clear at this time how to assess fully the impact and to initiate mitigating actions. Undoubtedly the potential impact could drastically change the current demographic environment. Only close adherence to the proposed areas for development and the suggested development guidelines will lessen this potential impact upon the natural environment.

4. Land Ownership

IMPACT: As most of the land within the Canyon is held in ownership by three parties--the United States Government (Forest Service), Burlington Northern, Inc., and Big Sky of Montana, Inc., any environmental impacts will center around the development and management plans of these three landowners. The impact of recent exchanges between the Federal Government and Burlington Northern has been thoroughly analyzed in a previous statement prepared by the U. S. Forest Service, and should be referred to for a thorough discussion of these exchanges.**

MITIGATION: These emerging land ownership patterns within the Canyon will enable individual owners the opportunity to more effectively and efficiently manage their holdings. Adoption of and adherence to guidelines in the Comprehensive Plan, and adoption of a common-goal multiple use management plan, will help to insure the compatibility of proposed land uses with the natural environment.

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*Environmental Impact Statement, (1971)

**Final Environmental Statement, (1971)

5. Economic Environment

IMPACT: The attractive landscape of the Gallatin Canyon, together with generally increasing development in recreational activities can only serve to enhance economic development within the Canyon. Undoubtedly the Big Sky development will alter the tax base of the area, creating additional revenue for the County.

MITIGATION: A complete economic analysis is needed to assess fully the impact of required county services in relation to projected increases in tax revenues. There appears to be little market for on-site labor other than that necessitated by supplying local services and that associated with any buildout development programs.

6. Local and Regional Service

IMPACT: There are no specific provisions in the proposed Comprehensive Plan for schools, medical facilities, police and fire protection, sanitary and solid waste disposal, electrical power, and water supply service--only guidelines for the provision of these services. These public services will have to be provided as the Canyon develops. Severe impact can be expected to the natural environment if strict measures are not taken to control sanitary and solid waste disposal.

MITIGATION: Detailed plans for the provision of these public services should accompany each development plan. It would be unrealistic to assume the County will provide each of the necessary services. Specific guidelines are proposed in the Comprehensive Plan relating to schools and sanitary waste disposal, and should be followed to protect the natural environment from degradation.

7. Aesthetic or Scenic Quality

IMPACT: Land development possible under the Comprehensive Plan could significantly alter the scenic quality of the Canyon. The general attractiveness of this rural mountain landscape could be altered by potential homes creating a real suburban character. Uncontrolled building could create a visual blight to the landscape that would be prohibitive to erase. A continuation of logging activities under current practices could eventually lead to a complete change in vegetative cover, resulting in a true loss of the real recreation potential. Excessive removal of vegetation could result in a loss or change of habitat, affecting the wildlife which contribute to the aesthetic quality of the Canyon.

MITIGATION: Degrading impacts to the visual environment can be reduced by good planning and design, as well as by thoughtful forest management. Many of the provisions in the proposed development guidelines--clustered developments, use of natural screening, careful site planning, sign control--will help to lessen the visual impact. Specific cutting prescription programs, suggested in the guidelines, will help to lessen the visual impact of logging activities. Only thorough cooperation in controlling the visual environment will protect the highly valued natural scenic qualities of the Canyon.

Adverse Environmental Effects Which Cannot be Avoided if the Plan is to be Implemented

Comprehensive Plan

NATURAL.

1. Degradation of wildlife habitat areas.
2. Partial removal of existing vegetative cover.
3. Acceleration of erosion.
4. Increase in fire hazard.
5. Accelerated use of ground waters.

CULTURAL.

1. Increse in traffic.
2. Change in rural scenic quality of the area.
3. Increased pressure on recreational resources.
4. Dramatic change in land use.
5. Increase in local resident population.
6. Accelerated demands on Gallatin County Services.
7. Increase in general noise levels (seasonal (fluctuations).
8. Possible increases in air pollution.

Desirable Environmental Effects Which Will Occur if the Comprehensive Plan is Implemented

NATURAL.

1. Implementation of water quality monitoring program.
2. Improved forest utilization and management.

CULTURAL.

1. Improved land use management.
2. Enhancement to the visual environment.
3. Expanded recreation activities.
4. Tax base increase.
5. Increasing pressure through demands for public services (schools, fire and police protection, etc.).
6. Control over sanitary waste disposal.

If the proposed zoning ordinances are legally adopted to guide implementation of the Plan, there will be even more desirable environmental effects.

Irreversible Environmental Changes that Would Occur Should the Proposed Comprehensive Plan be Implemented

Commitment of approximately 23,900 acres of forest, grazing, and watershed lands to seasonal residential/recreational development.

Alternatives to the Proposed Comprehensive Plan

Several alternative land use concepts were considered prior to developing the Comprehensive Plan concept. For a complete discussion of these alternatives see page 163 of this report.

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APPENDIX

FORREST H ANDERSON
GOVERNOR

MONTANA HIGHWAY COMMISSION

HELENA, MONTANA 59601

[redacted]
H. J. ANDERSON
DIRECTOR OF HIGHWAYS

February 15, 1972

IN REPLY REFER TO
26-PRD

Larry Lea
Senior Planner
The Murray-McCormick Environmental Group
617 19th Street
Sacramento, California 95814

Dear Mr. Lea:

Your letter of January 20, 1972 concerning the Gallatin Canyon and Interstate 15 has beenreferred to this department for reply.

Our studies have indicated that the completion of I-15 will have very little impact on truck traffic volumes through the Gallatin Canyon as U.S. 191 will still be a substantially shorter route for south to east traffic from Idaho Falls to points east of Bozeman.

The proposed link between the Ski Village near Big Sky and the Madison Valley near Ennis has not been definitely located to date and it has not been placed on any approved Federal Aid System. A spur from U.S. 191 to the proposed Ski Village, a distance of about nine miles, has been approved as an addition to the Federal Aid Primary System, and will probably be let to contract during 1972. Under present Federal Aid funding it is doubtful if the proposed extension of this route to the Madison Valley could be constructed within the next 20 years.

We have noted the average daily traffic volumes for 1970 and 1971 on U.S. 191 through the Canyon on the enclosed maps as you requested.

Very truly yours,

H. J. ANDERSON
Director of Highways

By Paul R. DeVine
Paul R. DeVine
Chief-Planning & Research Bureau

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